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General purpose technologies 'Engines of growth'?

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Abstract

Whole eras of technical progress and growth appear to be driven by a few 'General Purpose Technologies' (GPT's), such as the steam engine, the electric motor, and semiconductors. GPT's are characterized by pervasiveness, inherent potential for technical improvements, and 'innovational complementarities', giving rise to increasing returns-to-scale. However, a decentralized economy will have difficulty in fully exploiting the growth opportunities of GPT's: arms-length market transactions between the GPT and its users may result in 'too little, too late' innovation. Likewise, difficulties in forecasting the technological developments of the other side can lower the rate of technical advance of all sectors.

Key words: Technical change; Growth; Social returns; Coordination
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1. Introduction

Economists have known for a long time that technical change is the single most important force driving the secular process of growth (Abramovitz, 1956; Solow, 1957). Yet, relatively little progress has been made in accounting for the

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'residual' of aggregate production functions,[1] largely because economic theory tends to treat all forms of technical change in the same, diffuse manner. In fact, we can hardly distinguish in our models between a momentous invention such as the transistor and the development of yet another electronic gadget.

By contrast, economic historians emphasize the role played by key technologies in the process of growth, such as the steam engine, the factory system, electricity, and semiconductors (Landes, 1969; Rosenberg, 1982). Anecdotal evidence aside, are there such things as 'technological prime movers'? Could it be that a handful of technologies had a dramatic impact on growth over extended periods of time? What is there in the nature of the steam engine, the electric motor, or the silicon wafer, that make them prime 'suspects' of having played such a role?

In this paper we attempt to forge a link between the economic incentives for developing specific technologies and the process of growth. The central notion is that, at any point of time, there are a handful of 'general purpose technologies' (GPT's) characterized by the potential for pervasive use in a wide range of sectors and by their technological dynamism. As a GPT evolves and advances it spreads throughout the economy, bringing about and fostering generalized productivity gains.

Most GPT's play the role of 'enabling technologies', opening up new opportunities rather than offering complete, final solutions. For example, the productivity gains associated with the introduction of electric motors in manufacturing were not limited to a reduction in energy costs. The new energy source fostered the more efficient design of factories, taking advantage of the newfound flexibility of electric power. Similarly, the users of micro-electronics are among the most innovative industries of modern economies, and they benefit from the surging power of silicon by wrapping around the integrated circuits their own technical advances. This phenomenon involves what we call 'innovational complementarities' (IC), that is, the productivity of R&D in a downstream sector increases as a consequence of innovation in the GPT technology.[2] These complementarities magnify the effects of innovation in the GPT, and help propagate them throughout the economy.

Like other increasing returns-to-scale phenomena, IC create both opportunities and problems for economic growth through technical advance. Development of GPT-using applications in a wide variety of sectors raises the return to new advances in the GPT. Advances in GPT technology lead to new opportunities for applications. Such positive feedbacks can reinforce rapid technical

[1] See, however, the series of papers in Parts II and IV of Griliches (1988).

[2] In defining innovational complementarities and understanding their role, we were strongly influenced by Rosenberg's insightful 1979 essay, 'Technological Interdependence in the American Economy', reproduced in Rosenberg (1982). The formal analysis is close in spirit to that of Milgrom et al. (1991).

progress and economic growth. The problem is that these complementary innovative activities are widely dispersed throughout the economy, making it very difficult to coordinate and provide adequate innovation incentives to the GPT and application sectors.

These difficulties are hardly surprising, considering that uncertainty and asymmetric information, which make coordination difficult, are essential features of the process of new knowledge creation (Arrow, 1962). Moreover, time gaps and sequentiality are an inherent feature of technological development, particularly in the context of GPT's (e.g., the transistor could not come before electricity, nor could interferon before DNA). Therefore, coordination in this context would require aligning the incentives of agents located far from each other along the time and the technology dimensions. Since GPT's are connected by definition to wide segments of the economy, coordination failures of this nature may have far reaching consequences for growth.

A great deal of theoretical work has been done in recent years on the role of increasing returns in endogenous growth, going back to Romer's (1986) contribution. However, many of these models regard the economy as 'flat', in that they do not allow for explicit interactions between different sectors.[3] The *locus* of technical change does not matter much in those models, and hence there is little room to discuss explicitly the industrial organization of inventing sectors. Closely related, technical change is often assumed to be all-pervasive, that is, to occur with similar intensity everywhere throughout the economy. Clearly, one could not build a theory of growth that depends upon the details of bilateral market relations, when those details could refer to any or all of the myriad markets that make up the economy. By contrast, we identify here a particular sector (the GPT prevalent in each 'era') that we regard as critical in fostering technical advance in a wide range of user industries, and presumably in 'driving' the growth of the whole economy. The price that we pay, though, for the sharp focus is that the analysis is partial equilibrium, and hence the implications for aggregate growth stem just from the supply side, and abstract from general equilibrium type of feedbacks.[4]

We organize the analysis in order to draw two sets of implications out of a simple model of decentralized technological progress. In Sections 2 and 3 we consider the implications of generality of purpose and innovational complementarities for the economy-wide incentive to innovate. These sections emphasize the vertical relations between the procedures in GPT and application sectors, and the dual appropriability problem that arises in that context. Section

[3] For a notable exception see Grossman and Helpman (1991), particularly their models of the product cycle.

[4] Murphy et al. (1989) show that partial equilibrium implications are robust to general equilibrium considerations in a model with aggregate logic much like ours, but different microfoundations.

4 turns to a set of dynamic issues: the role of bilateral inducement of technical progress over time, the difficulties of the GPT and AS sectors in forecasting each others' rate of progress, and the consequent 'too little, too late' decisions that slow the arrival of social gains from a GPT. Section 6 concludes with directions for further research.

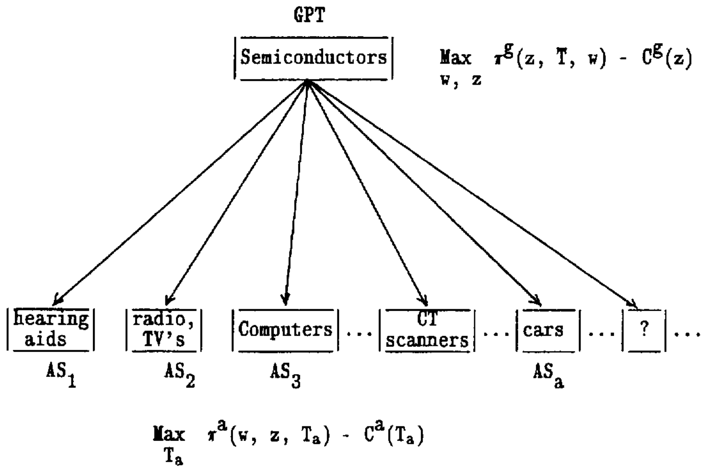
One of Zvi Griliches's earliest contributions was the study of hybrid corn, a technology that can surely be regarded as a GPT in the context of agriculture. Indeed, that is how Griliches himself (1957, p. 501) perceived it: 'Hybrid corn was the invention of a method of inventing, a method of breeding superior corn for specific localities.' Many of the themes of our analysis are also familiar from Griliche's work: the private incentive to adopt new technologies (Griliches, 1957), the return to innovations at the firm level (Griliches, 1958, 1984), and the causes and consequences of returns-to-scale (Griliches, 1971). This paper attempts to integrate these themes in the hope of illuminating some broader phenomena.

2. Incentives to innovate in the GPT and application sectors

Several common themes emerge from surveying past and present GPT's.[5] A generic function (or 'general concept') such as 'continuous rotary motion' for the steam engine, or 'transistorized binary logic' for the integrated circuit, can be applied in many sectors. Yet advancing the performance of objects embodying these functions and making them economically viable pose great challenges. Thus, cheaper steam power called for mechanically better engines using improved materials, and a superior understanding of thermal efficiency. More advanced integrated circuits have their own complex logic, but also call for advances in photolithography and other manufacturing processes. Finally, making the general concept work in any specific situation requires further complementary innovation, and often a great deal of ingenuity. Who knew that continuous rotary motion could make sewing cheaper, or that carburetion in an automobile engine and addressing envelopes were binary logic activities? These observations about technology inform and drive the forthcoming analysis.

Our model is of a stylized set of related industries with highly decentralized technical progress, centered around the GPT. To fix ideas, think of this sector as semiconductors. The level of technology in that sector, called z, appears to users in the application sectors as quality attributes. In semiconductors these are the speed, complexity, functionality, size, power consumption, reliability, etc. of integrated circuits. While almost all interesting real-world examples have

[5] We do not attempt any serious review of the relevant technological facts here. Section 2 of Bresnahan and Trajtenberg (1992) has more detail. See also Mokyr (1990) and David (1990).



Notation:

GPT:	General Purpose Technology
AS_a:	Application Sector a
z:	"Quality" of the GPT
w:	Market price of the GPT
c:	Marginal cost of GPT
T_a:	Technological level (or "performance") of AS_a (**T**: vector of T_a's)
π^g, π^a:	Gross rents of the ith sector, i: GPT, AS_a
C^i:	R&D costs of the ith sector, i: GPT, AS_a

Fig. 1. The framework of analysis.

multidimensional z, we formulate the model in terms of a scalar z.[6] Finally, the economic return to improved technology in the GPT comes by selling a good embodying the technology at price w, in markets where the GPT firm(s) exercise some degree of monopoly power. The economic incentives for innovation in the GPT depend on the prevailing market structure and appropriability, as well as on the demand function in the applications sectors, which determines GPT revenue as a function of w and z.

In this framework an applications sector (AS) is an actual or potential user of the GPT as an input; each AS engages in its own innovative activity, leading to a level of own technology T_a. Fig. 1 shows some the AS's using semiconductors:

[6] Think of it as the density with which transistors can be packed on a chip, the fundamental level of semiconductor technology which permits advances along most of the quality axes.

early transistors were incorporated in hearing aids, shortly after in radios, computers, and then television sets. The development of the integrated circuit permitted applications in many entirely new products (e.g., CT scanners, camcorders). A particularly important subclass of integrated circuits is microprocessors, which permitted the creation of 'smart devices' (personal computers, laser printers, automobile engine control systems). In parallel to the appearance of new applications, the GPT fosters continued change in existing sectors such as military or civilian aircraft. More generally, adapting and adopting the GPT for different sectors is itself an innovative activity. For GPT's as pervasive as semiconductors, innovation in the different AS's can be very diverse. What is shared among applications sectors is the level of GPT technology and not necessarily any other economic feature.[7]

We begin by modelling the incentives to innovate facing the GPT and AS's. The key technical assumptions are generality of purpose and innovational complementarities.[8] These translate, in a world of imperfect appropriability, into two distinct externalities: the 'vertical' externality between the GPT and each application sector, and the 'horizontal' one across application sectors. We then examine the welfare consequences of these externalities in the context of a simple one-step innovation game.

2.1. Modelling the application sectors

Each application sector (indexed by a) determines the level of its own technology, $T_a \geqslant 0$, and its demand for the GPT good, X^a. The objective function which the single AS acts *as if* it maximizes is

$$\max_{T_a} \Pi^a(w, z, T_a) - C^a(T_a) \equiv V^a(w, z), \tag{1}$$

where $C^a(\cdot)$ are invention costs and Π^a stands for the gross private returns to technical advance in the AS. We assume that if $V^a(w, z) < 0$ the sector takes

[7] Not all historically important GPT's have this industrial organization. Many developments in early steam engine technology, for example, took place inside using industries such as mining and transportation. Our modelling strategy is to associate each technology with a separate economic agent, so as to illuminate the incentive to innovate for each. We then revisit the question of how these agents might be organized, by firms, contracts and markets.

[8] We omit here two additional forces that are thought to play a similar role: Technological interrelatedess and diffusion in conjunction with learning-by-doing. The first means that there is 'learning by inventing'. The invention of particular subtechnology in the context of a GPT lowers the cost of inventing the next one, which, in turn, contributes to span other subtechnologies further down the line. The second is more conventional: As the number of downstream sectors using the GPT increases, the costs of producing the generalized input go down because of 'learning-by-doing', thus contributing to a self-sustained process of economy-wide growth.

some opportunity action with value normalized to zero.[9] The definitions of z, T, and w imply that $\Pi_Z^a > 0$, $\Pi_T^a > 0$, and $\Pi_W^a < 0$.

It is standard in models of vertical integration to treat the downstream sector as a single entity, and hence to refer to Π^a as 'the' payoff to the AS, without distinguishing between buyers and sellers within the sector; see, for example, Hart (1988) and Bolton and Whinston (1993). In general, though we do not expect market arrangements within any given AS to result in optimal innovation incentives. Thus, we provide in Section 2.2 three examples of the economic underpinnings of Π^a; in all of them Π^a moves together with social surplus in response to changes in z, w, or T_a, but only in one of the examples Π^a is identical to social surplus.

As usual in these types of models, we assume $C_T^a > 0$ and $C_{TT}^a > 0$. Most importantly, we assume the presence of 'innovational complementarities' (IC),

$$\Pi_{zT}^a \geqslant 0. \tag{2}$$

In words, the marginal value of enhancing the AS's own technology rises with the quality of the GPT. The solution to (1) leads to the technology investment function of the AS,

$$T_a = R^a(w, z). \tag{3}$$

It is immediate from the assumption of IC that $R^a(\cdot)$ is upward-sloping in z: technological improvements in the GPT *induce* complementary innovation in the AS. Relying on Shephard's lemma, the demand of the AS for the GPT input is given by

$$X^a(w, z, T_a) = -\Pi_w^a(w, z, T_a), \tag{4}$$

and hence the expenditure on purchasing the GPT input is $E^a = wX^a(w, z, T_a)$, which is obviously the revenue function of the GPT. Since the GPT sector will be assumed to exercise monopoly power, it is convenient to state some of the assumptions in terms of the 'inverse' marginal revenue function, $\widetilde{MR} \equiv \partial E^a/\partial w = (X^a + wX_w^a)$.

We assume that demand is downward-sloping ($X_w < 0$) and that $X_{T_a} > 0$, $X_Z > 0$, that is, that superior technology is demand-enhancing. We also assume that $X_{WZ} \leqslant 0$, which implies that demand does not become steeper as it shifts up following a quality upgrade in the GPT. This ensures that a GPT monopolist cannot appropriate more than the incremental surplus stemming from an

[9] If the GPT is critical for the very existence of the AS (e.g., semiconductors in microcomputers), then the value of the 'opportunity action' is identically zero; if the GPT is a noncritical enhancement (e.g., semiconductors in motor vehicle engine control), the opportunity action would be the use of an alternative technology.

increase in z, Π^a_z; thus, the GPT producer will underprovide z (as in Spence, 1975).

We make the following assumptions about the derivatives of $\widetilde{MR}$ (mirroring those about demand):

$$\widetilde{MR}_w = -(2\Pi^a_{ww} + w\Pi^a_{www}) < 0,$$

$$\widetilde{MR}_{T_a} = -(\Pi^a_{wT_a} + w\Pi^a_{wwT_a}) > 0,$$

$$\widetilde{MR}_z = -(\Pi^a_{wz} + w\Pi^a_{wwz}) > 0,$$

that is, z and T_a are assumed to shift marginal revenue in the same direction as the shift in demand; these, together with the (conventional) assumption that $\widetilde{MR}_w < 0$, ensure that the return to the GPT producer from investing in quality upgrades increases with T_a (see Appendix 1).

So far we have discussed the behavior of a single application sector, but the very concept of a GPT implies the existence of multiple AS's. For simplicity, assume that for all $\{z, w\}$ the ranking of AS's according to the maximized value of their payoff, $V^a(w, z)$, is the same. In that case the marginal AS is uniquely determined by the smallest positive $V^a(w, z)$. Let $A(w, z)$ be the set of sectors that find it profitable to use the GPT; clearly, $A(\cdot)$ will include more sectors the larger z is, and fewer sectors the higher is w. Thus, holding prices fixed, higher z's induce higher level of T_a in each active AS, and cause an expansion of the set of AS's by making it profitable for extramarginal sectors to adopt the GPT.

2.2. Examples of the economic underpinnings of Π^a

We provide here three alternative interpretations of $\Pi^a(\cdot)$, all having distinct buyers and sellers within each AS: sellers purchase the GPT good, combine it with their own technology, and sell their output to buyers. The examples differ in the assumptions regarding the industrial organization of the AS, and therefore in the relationship between Π^a and total surplus.

Consider first the case where there is perfect, costless contracting between buyers and sellers in the AS, and hence assume that they are able to design the cost-minimizing industry structure (just as they would if they were to vertically integrate). That is, they sign contracts which just cover $C^a(T_a)$ without affecting any allocational decision at the margin. Let the payoff to buyers be equal to the consumer surplus, $CS(P_a, z, T_a)$, where P_a is the price of the AS good;[10] thus, quantity demanded equals $-CS_P(P_a, z, T_a)$. On the supply side, denote by

[10] In our semiconductor example, the surplus could result from using personal computers based on microprocessors of quality z, and embodying computer architectures and other components of quality T.

$\gamma(z, T_a)$ the unit cost function, and assume that one unit of the AS good uses one unit of the GPT input (as one microcomputer uses one microprocessor). Then,

$$\Pi^a(w, z, T_a) \equiv \max_{P_a} CS(P_a, z, T_a) - [\gamma(z, T_a) + w][-CS_{P_a}(P_a, z, T_a)], \tag{5}$$

that is, Π^a maximizes consumers' surplus minus costs, including the costs of buying the GPT good. In other words, the AS acts in this case *as if* it maximizes total surplus of the sector.[11]

Eq. (5) shows also that one of the likely sources of innovational complementarities (IC) is $CS_{zT} > 0$. For example, final demanders of hearing aids are better off only if the quality of the transistor z is designed into the listening device via T_a. It is the quality of their improved hearing, which relies on the two technologies, that drives the IC in Π^a. Notice also that $P_a = \gamma(z, T_a)$, and hence $X^a(w, z, T_a) = -CS_{P_a}[\gamma(z, T_a), z, T_a]$. This may provide a rationale for the assumption that $X_{zT} > 0$, which we shall rely upon later on: the assumption holds if the IC arise indeed from $CS_{zT} > 0$.

The first-best contracts of the previous example may be difficult to negotiate or enforce. As a second example, suppose instead that price-taking buyers face a monopoly seller in the AS. Then, using the same notation,

$$\Pi^a(w, z, T_a) \equiv \max_{P_a} [P_a - \gamma(z, T_a) - w][-CS_{P_a}(P_a, z, T_a)].$$

Thus, Π^a is in this case the part of the surplus that is captured by the monopoly seller, and not *total* surplus as in the first example.[12]

As a third and final example, suppose that the *sellers* in the AS are price takers; once again Π^a would be producer's surplus in the AS, which will be zero if the firms in the AS are all identical with flat marginal costs. Clearly, the gap between Π^a and social welfare will be larger than in the monopoly case.

These examples make it clear that in a wide range of cases the payoff function governing the behavior of the AS is highly correlated with total sector surplus, though not necessarily identical to it. In any event, our analysis focuses on the efficiency of the productive sector of the economy, and abstracts from spillouts to the consumers of the AS's.

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[11] Note that this formulation takes T_a as given and assumes that $C^a(T_a)$ is financed according to the terms of the contract struck between buyers and sellers.

[12] Notice that in this case the demand for the GPT input is $X^a(w, z, T_a) = X^a[\gamma(z, T_a)/(1 + \eta^{-1}), z, T_a]$, where η is the elasticity of demand for the AS goods.

2.3. Incentives for innovation in the GPT sector

We assume that the GPT sector sells an undifferentiated product and that it exercises monopoly power in setting its price w.[13] Thus, the restricted profit function is

$$\Pi^g(z, \bar{T}, c) \equiv \max_w (w - c) \sum_{a \in A} X^a(w, z, T_a), \tag{6}$$

where c is the constant marginal cost of producing the good embodying the GPT, $\bar{T}$ is the *vector* of technology levels of the AS's, and $A = A(w, z)$. The innovating behavior of the sector is characterized by (for $z \geqslant 0$)

$$\max_z \Pi^g(z, \bar{T}, c) - C^g(z), \tag{7}$$

where $C^g(z)$ stands for the cost-of-innovating function, exhibiting $C_z > 0$ and $C_{zz} > 0$. The solution to (7) gives us the reaction function

$$z = R^g(\bar{T}, c),$$

which will be upward sloping in $\bar{T}$ (the proof is in Appendix 1): we have assumed that higher T_a's shift demand *and* marginal revenue up, hence the private return to investment in z increases with T_a.

This is then the second half of a dual inducement mechanism: an improvement in the technology of any AS increases the incentives for the GPT to upgrade its technology, just as a higher z prompts the AS's to invest in higher T_a's. The technology levels of the AS's and of the GPT, $\{\bar{T}, z\}$, can be thus characterized as 'strategic complements' (Bulow et al., 1985).

2.4. Equilibrium in the market for the GPT and the social optimum

Assuming that the GPT and the AS's engage in arms-length market transactions (and hence ruling out technological contracting or other forms of cooperative solutions), we can easily characterize the (Nash) equilibrium as follows (we rely here on Milgrom and Roberts, 1990): $\{\bar{T}^o, z^o\}$ is an equilibrium if

$$T_a^o = R^a(z^o), \quad \forall a, \quad \text{and} \quad z^o = R^g(\bar{T}^o),$$

where for some AS's it may be that $T_a^o = 0$. The multiplicity of potential participant AS's will tend to induce multiple equilibria. There is always a 'low' equilibrium (i.e., $\{0, 0\}$) and, if the reaction functions are concave, at least one

[13] We abstract from the internal organization of the GPT 'sector', and treat it as a monopoly; however, the analysis below holds for pricing rules other than monopoly pricing.

interior equilibrium. Different numbers of participating AS's may support other interior equilibria as well. Moreover, one can always define *constrained* equilibria, one for each subset $A \subseteq \hat{A}$, where $\hat{A}$ is the superset of all possible AS's. The plausibility of alternative equilibria is interesting in itself; however, here we are interested primarily in analyzing the efficiency of different vertical arrangements *vis-a-vis* the social optimum. Thus, for comparison purposes we choose the 'best' decentralized equilibrium, that is, the one exhibiting the largest A, denoted by A^o, which will be associated also with the largest z^o and $\bar{T}^o$.

Now to the social optimum. First we impose marginal cost pricing ($w = c$), which implies $\Pi^g = 0$. For any $A \subseteq \hat{A}$ the social planner's problem is

$$\max_{z,\,T_a} \left[\sum_{a \in A} \Pi^a(c, z, T_a) - \sum_{a \in A} C^a(T_a) - C^g(z) \right] \equiv S(A). \tag{8}$$

Denoted by $\{T^*, z^*\}$ the arguments that fulfill (8); likewise,

$$A^* = \operatorname*{argmax}_{A} S(A).$$

Proposition 1.[14] *The social optimum entails higher technological levels than the decentralized equilibrium, i.e.,* $z^* > z^o$, $T_a^* > T_a^o$, $\forall a$, *and* $A^o \subseteq A^*$.

The reason for the divergence between the social optimum and the decentralized Nash equilibrium lies in the complementarities between the two inventive activities and the positive feedbacks that are generated. Consider the following thought experiment: starting from the social optimum $\{z^*, \bar{T}^*\}$ and reasoning 'backwards', each player would want to innovate *less*: lowering z lowers each T_a which, in turn, means less commercial opportunity for the GPT sector, and hence a lower z. Moreover, a lower z means lower Π^a's, resulting in reductions in the size of $A(w, z)$ as some AS's payoffs to utilizing the GPT become negative. This means that the market for the GPT shrinks, prompting a further cutback in z, and hence in the T_a of those applications sectors that remain active.

It is important to note that the assumption of monopoly pricing by the GPT is *not* the villain, as can be seen by considering alternative pricing mechanism. First, pick a pricing rule that gives the AS's the right incentives to innovate: the only such rule is $w = c$, which leads to no appropriability and thus no innovation in the GPT. Second, attempt to pick a pricing rule that gives the GPT the social rate of return to innovation. Clearly, a single $w(\cdot)$ would not suffice, only the perfectly price-discriminating GPT monopolist would earn the social return.

[14] The proof closely follows Cooper and John (1988) and Milgrom and Shannon (1992), and hence we omit it. We note only that it relies on $R^a(z)$ and $R^g(\bar{T})$ being upward-sloping and on the assumption that $X_{zw} \leqslant 0$ (made in Section 2.1), which implies $\Pi^g_z(\cdot) \leqslant \Sigma_{a \in A} \Pi^a_z(\cdot)$.

But price discrimination would leave zero returns to technical advance in the AS's. A fully specified technology contract might solve the problem if it is binding (a big 'if'), but that just underlies the point made here: any arms-length market mechanism under innovational complementarities necessarily entails private returns that fall short of social returns for either upstream or downstream innovations, under *all* plausible pricing rules.

3. Two positive externalities

The feedback mechanism leading to social rates of return greater than private returns reflects two fundamental externalities. The first is vertical, linking the payoffs of the inventors of the two complementary assets, and follows from innovational complementarities. The second is horizontal, linking the interests of players in different application sectors, and is an immediate consequence of generality of purpose.

The vertical externality is closely related to the familiar problem of appropriability, except that here it runs both ways, and hence corresponds to a *bilateral* moral hazard problem (Holmstrom, 1982; Tirole, 1988). Firms in any AS and GPT sector have linked payoffs; the upstream firm would innovate only if there is a mechanism (involving $w > c$) that allows it to appropriate some of the social returns. The trouble is that, for any $w > c$, the private incentive for downstream innovation is too low. Thus, any feasible pricing rule implies that neither side will have sufficient incentives to innovate.

Recently, several scholars as well as industrial advocates have suggested broad-based changes in government policy to increase appropriability in sectors that would qualify as GPT's (primarily semiconductors). Typically, these policy initiatives concern intellectual property protection, limits on foreign competition, and the relaxation of antitrust standards for these sectors. Our analyses suggests that policy measures of this nature cannnot sensibly be evaluated in isolation. To be sure, such measures would improve the incentive to innovate in the GPT sector, but they might also lower the returns to complementary investments made by users of the GPT throughout the economy.

The second externality stems from the generality of purpose of the GPT. From the vantage point of the GPT, the AS's represent commercial opportunity; thus, the more AS's there are and the larger their demands, the higher will be the level of investment in the GPT technology. From the point of view of the AS's, expansions in the set A, enhancements to T_a, and increases in the willingness to pay for the GPT by any AS's makes all other AS's better off by raising z. Yet, in equilibrium, each AS finds itself with too few 'sister sectors', each innovating too little.[15] The point is that z acts like a public good while R^g is the fixed cost needed to produce that good. However, in contrast to the traditional analysis of public goods, attempts to cover such costs with transfer prices impose a tax that discourages innovation.

The horizontal externality illuminates policy issues in the economics of technology connected with the role of large, predictable demanders. It is often claimed that the procurement policy of the U.S. Department of Defense (DOD) and NASA 'built' the microelectronics-based portion of the electronics industry in the U.S. during the fifties and sixties. Obviously, the presence of a large demander changes the conditions of supply, and this may benefit other demanders. However, NASA and the DOD also had a high willingness to pay for components embodying z well outside current technical capabilities, and were willing to shoulder much of the risk through procurement assurances. In so doing NASA and the DOD may have indeed set in motion (and sustained for a while) the virtuous cycle mediated by the horizontal externality.

However, it is only a coincidence that the horizontal spillouts came from the demand activities of government agencies. In the same technology, large private demanders such as the Bell System and IBM contributed directly to the development of fundamental advances in microelectronics. Earlier GPT's displayed similar patterns, as for example in Rosenberg's (1982) description of the importance of improvements in the quality of materials for 19th century U.S. growth. Much of the private return to improvements in material sciences (and engineering) came from a few key *private* sectors, notably transportation. The need to build steel rails for the railroad and to contain steam in both railroads and steamships provided a type of demand parallel to that of the government body noted above. Focused on improvements in inputs that press the technical envelope, having high willingness to pay because of their own technological dynamism, such demanders provide substantial horizontal spillouts to the extent that the technical progress that they induce is generally useful.

These examples seem to suggest that 'triggers' often take the form of exogenous forces that shift the rate of return to GPT technology. Thus in the 19th century, the importance of certain sectors (e.g., transportation), driven by the economic development of the country, may have been the key. In the post Wold War II era, the onset of the Cold War resulted in a government procurement policy which may have played a similar role. In each case, the positive feedback aspects of GPT and AS developments then took over, generating very large external effects, and unleashing a process of technical change and growth that played out for decades.

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[15] Note that this issue arises above and beyond the multiple equilibrium problem, since we have assumed that the 'best' Nash equilibrium is the one that holds.

3.1. Externalities and technological contracting

Clearly, the vertical and horizontal externalities offer strong motives for breaking away from the limitations of arms-length market transactions, by increasing the degree of cooperation and explicit contracting between AS's and the GPT and between the AS's themselves. To illustrate, consider the case where any two sectors can form a binding technology contract, be it the GPT sector and an AS or a pair of AS's. In the former case they will pick z and T_a to maximize $(\Pi^a + \Pi^g)$; in the latter, they will pick the two T_a's to maximize the sum of the two AS's payoffs. The result of either contract will be that z and T_a will be larger for *all* application sectors. Payoffs will be larger for the GPT sector and for all AS's not party to the contract as well. Note, however, that the activity of forming binding technology contracts is subject to the same externality as the provision of technology itself. Just as every AS would like to see other AS's advancing their own technology, so too each sector would like to see others making technology-development contracts with the GPT. Clearly, lack of enforceability as well as imperfect technology forecasting limit the practical importance of contracting.

Recent events in the computer and telecommunications markets show how these considerations work in the real world. For many years, coordination between GPT-related sectors and their AS's was made simpler by the presence of dominant firms such as IBM and AT&T. These firms took a leading role not only in the development of the GPT, but also in the encouragement of complementary innovations in specific directions. This ability to commit to specific technological trajectories and therefore to direct the overall innovation cluster was labelled 'credibility' by those AS who benefited from the tacit coordination, whereas those that did not saw it just as the exercise of plain market power.

Over time, technological and regulatory forces have significantly reduced the leading role of these dominant firms. There is no longer a single actor who can direct technical progress, but instead there are a few innovators of both complementary and competing technologies that influence the gradient of advance in GPT-related industries. In parallel, a wide range of weaker mechanisms have emerged for coordinating and directing technical progress. 'Strategic alliances', participation in formal standards-setting processes, consortia, software 'missionaries', and the systematic manipulation of the trade press have all emerged as standard management tools in micro-electronics-based industries. These mechanisms permit both revelation of the likely direction of technical advance within particular technologies and the encouragement of complementary innovations. Yet they probably fall short of offering the means to internalize the bulk of the externalities discussed above.

4. The dynamics of general purpose technologies

In previous sections we assumed a one-shot game, allowing us to discuss the two main externalities associated with GPT's. We turn now to dynamic aspects of the performance of GPT's, such as the role of informational flows between sectors and their implications for growth. A suitable framework to model the way by which the innovational efforts of the GPT and the AS's unfold and interact over time is the theory of dynamic oligopoly as developed by Maskin and Tirole (1987) (henceforth M&T), which centers around the concept of Markov Perfect Equilibrium (MPE).[16] In what follows we sketch the model and (re)state the pertinent results from M&T in terms of GPT's and AS's.

Denote by $\pi^a(z_t, T_t)$ the instantaneous profit function of the AS and by $\pi^g(z_t, T_t)$ that of the GPT (for simplicity we assume that w is fixed).[17] The GPT and the AS are assumed to move in alternate periods of fixed length τ. In the present context, τ has a natural interpretation, namely, it is the length of time it takes to develop the 'next generation' (either of the GPT or of the AS), given that the other side has already developed its current technology. Thus, the quality level of the GPT at time $t-1$ is z_{t-1} and it remains constant for the next two periods (i.e., for a length of time of 2τ). Given z_{t-1}, the AS develops its technology up to level T_t, over a period of length τ. Similarly, after the realization of T_t it takes the GPT τ to develop *its* next generation, z_{t+1}, which will be marketed in period $t+1$. We refer throughout to a single AS facing the GPT, since the case with multiple AS's is far more complex and hard to analyze.[18]

With no adjustment costs, each firm maximizes at time t,

$$\sum_{s=0}^{\infty} \delta^S \pi^i(z_{t+s}, T_{t+s}), \qquad i = a, g,$$

where $\delta = \exp(-r\tau)$ is the discount factor and r is the interest rate. Define a dynamic reaction function for Markov strategies (i.e., dependent only on the payoff-relevant state) for the AS as $T_t = R^a(z_{t-1})$ and, similarly for the GPT,

[16] A more thorough treatment, incorporating uncertainty explicitly, would follow Pakes and McGuire (1992); however, that is well beyond the scope of this paper.

[17] We assume that these instantaneous profit functions have the same derivative properties as their static analogs of previous sections, but we further assume that $\pi^i(\cdot)$, $i = a, g$, are bounded from above.

[18] We conjecture that the qualitative results will be the same if instead there are a few large AS that act in tandem *vis-a-vis* the GPT or if the GPT acts as a Stackelberg leader *vis-a-vis* many small AS's; however, further work needs to be done to prove that this is so, in particular one would have to deal appropriately with the problem of multiple equilibria.

$z_t = R^g(T_{t-1})$. The pair (R^a, R^g) form a MPE iff there exist valuation functions (V^i, W^i), $i = a, g$, such that (for the AS)

$$V^a(z) = \max_T \, [\pi^a(z, T) + \delta W^a(T)],$$

$$R^a(z) \quad \text{maximizes} \quad [\pi^a(z, T) + \delta W^a(T)],$$

$$W^a(T) = \pi^a[R^g(T), T] + \delta \, V^a[R^g(T)],$$

and analogous conditions hold for the GPT's valuation functions. It is easy to show that the reaction functions will be upward-sloping in this case, since the cross-derivatives of the payoff functions, π^i_{zT}, are positive (because of innovational complementarities).[19]

M&T prove that, for any discount factor δ, (i) there exists a unique linear MPE which is dynamically stable, and (ii) the equilibrium (steady state) values of the decision variables (z^e, T^e in the present case) equal the static Cournot–Nash equilibrium when $\delta = 0$, and grow with δ. An equivalent way of phrasing (ii) is that the (dynamic) reaction functions coincide with their static (or 'Cournot') counterparts as δ goes to zero.[20]

In order to verify that this proposition holds also for the case of positively sloped reaction functions, we run simulations of the MPE that results from various values of the discount factor over its whole range (i.e., $\delta \in [0, 1]$). As shown in Appendix 2, the long-term equilibrium values $\{z^e, T^e\}$ increase indeed with the discount factor, and that is true for any value of the other parameter in the system.[21]

The dependence of the long-run equilibrium upon the discount rate has interesting implications in our context. In order to explore them we first modify the model to include 'adjustment costs' since it is not quite plausible that R&D costs will be a function of the *absolute* level of z (or T) that the firm wants to achieve. Rather, it is more likely that R&D costs depend upon the intended *increments* in technology, that is, that they are a function of $\Delta z_t = (z_t - z_{t-1})$, and similarly for T. M&T elaborate on the MPE that obtains in the case of

[19] See the proof of Lemma 1 in M&T (pp. 950–951): the negative slope of the reaction function stems directly from the assumption that $\pi_{12} < 0$. Thus, the converse holds for $\pi_{12} > 0$ (which is the equivalent of our $\pi_{zT} > 0$).

[20] M&T prove the proposition for the special case of quadratic profit functions; Dana and Montrucchio (1986) generalized the proof for any concave payoff function; see also Dana and Montrucchio (1987).

[21] The other parameter is d, the constant in the quadratic profit function, which enters multiplicatively in the equations for z^e and T^e, and hence does not affect the relationship between them and δ.

quadratic profit functions, when adjustment costs take the form $(\alpha/2)(z_t - z_{t-1})^2$, resulting in the linear dynamic reaction functions[22]

$$R^a(Z_{t-1}, T_{t-2}) = b_0 + b_1 z_{t-1} + b_2 T_{t-2},$$
$$R^g(z_{t-2}, T_{t-1}) = b_0 + b_1 T_{t-1} + b_2 z_{t-2}. \tag{9}$$

The long-term equilibrium values are then easily computed as $T^e = z^e = b_0/(1 - b_1 - b_2)$. Since even this simple case does not have closed form solutions (except in the limiting case of a large α), we resort once again to simulations and find that the discount factor plays here the same role as without adjustment costs, that is, the equilibrium values $\{z^e, T^e\}$ increase in δ (see Appendix 2).[23] Thus, the monotonicity of $\{z^e, T^e\}$ with respect to the discount factor generalizes both for the case of strategic complements, and for the case with adjustment costs.

In the current context the discount factor δ can be interpreted as a measure of the difficulty in forecasting the technological developments of the other side: the smaller δ is, the more difficult it is for the AS to anticipate the future quality of the GPT, and vice versa.[24] Technological forecasting, in turn, depends upon a variety of institutional arrangements that may facilitate or hinder the flow of credible technological information between the GPT and the AS's. Thus, the above results imply that the more 'cooperative' the GPT and the AS's are in terms of informational exchanges, the higher the ultimate equilibrium levels $\{z^e, T^e\}$ will be, and, since the reaction functions are positively sloped, the larger the values $\{z_t, T_t\}$ will be at each step in the sequence leading towards the steady state (see Fig. 2). Larger values at each step may translate in turn into faster aggregate growth, provided that in the process the GPT diffuses throughout a large number of sectors in the economy.

Recalling that $\delta = \exp(-r\tau)$, a useful way of thinking of δ in the present context is as follows: Suppose that τ is the required overall development time of

[22] To recall, since M&T assume that the cross-derivatives of the profit function are negative, b_1 is in their case negative. Keep in mind that $\{b_0, b_1, b_2\}$ are unknowns, that are obtained by solving the system for the MPE. Here resides the main practical difficulty of the model, since the system of equations that needs to be solved (by simulations) in order to obtain $\{b_0, b_1, b_2\}$ can be very complex.

[23] We also find that $\{z^e, T^e\}$ increase with the shift parameter of the profit function and decrease with α, but these are hardly surprising results. The simulations were run assuming symmetry between the GPT and the AS, which is in this case rather implausible (if only because there are no natural units to define z and T); that is, however, a mere technicality: the truly limiting assumption is the functional form of the profit and adjustment costs functions.

[24] This is of course a shortcut to the explicit modelling of technological uncertainty, which would involve a game of incomplete information.

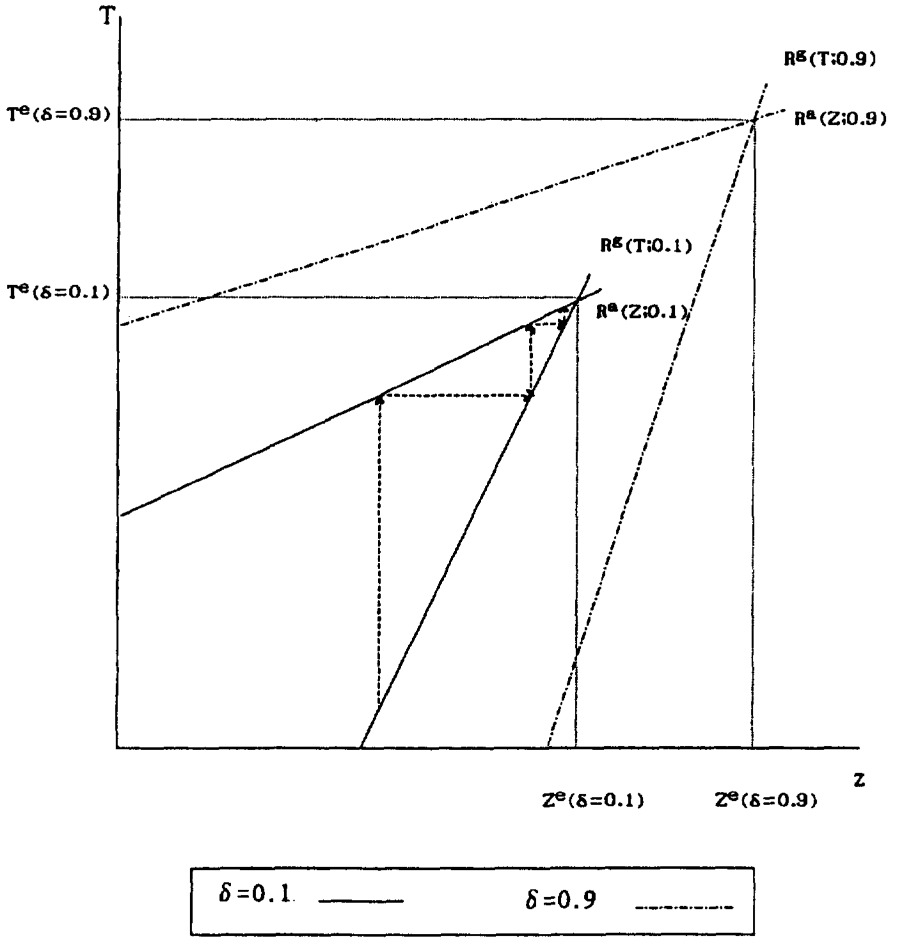


Fig. 2. Dynamic reaction functions, drawn on the basis of the numerical results shown in Table A.1, Case 1 [e.g., $z^e(\delta = 0.9) = T^e(\delta = 0.9) = 139$].

each 'new generation' of both the GPT and the AS. However, assume now that a proportion $(1 - \theta)$ of the development can be done before the other side has completed its development (which implies of course that a proportion θ *has to be done* afterwards). Thus, the 'effective' length of a period is $r^* \equiv \theta\tau$, $\theta \in [\underline{\theta}, \bar{\theta}]$, $\underline{\theta} > 0$, $\bar{\theta} \leqslant 1$; obviously, the smaller is θ, the larger δ will be [since $\delta = \exp(-\theta\tau^*) = \exp(-\theta\tau r)$].

If the relationship between the GPT and the AS takes the form of arms-length market transactions, with no intended exchange of technological information between them, then $\theta = \bar{\theta}$, hence δ will be small and so will $\{z^e, T^e\}$. On the other hand, if all technically relevant information flows freely between the two players, then $\theta = \underline{\theta}$, leading to faster innovation and higher levels of long-run equilibrium technologies. Thus the value of θ, reflecting institutional and organizational arrangements, may profoundly affect the present and future pace of innovation. Presumably, concerted action by the players involved as well as government policy may be able to alter θ and thus influence the rate of GPT-related technical change in the economy.

As an example, consider the case of Intel, Inc. *vis-a-vis* manufacturers of personal computers. The latter knew for quite a while that the next generation of Intel's microprocessors was the 586 (the 'Pentium'), that it was due in the spring of 1993, that it was expected to have at least twice the 486's performance (see Table 1), etc. On that basis they presumably were able to do part of the R&D for their next generation of PC's which will incorporate the 586. However, some of the development process requires that they actually get their hands on the 586,

Table 1
Successive generations of a GPT: Actual and expected

Intel's microprocessor dynasty		
Chip	Introduced	
8086/8088	1978/1979	The chips that powered the first IBM PC's and PC clones; they crunch numbers in 16-bit chunks but have limitations in use of computer memory
80286	1982	Speedier than the 8088/8086, the 80286 also enabled computers to run for larger programs; first appeared on the 1984 IBM PC/AT
80386	1985	First Intel 32-bit microprocessor, capable of processing data in 32-bit chunks; gave PC's power to do bigger jobs, like running networks
80386SX	1988	Lower-priced version of the 80386, aimed at killing off the 80286, which was also produced by Advanced Micro Devices
80486	1989	Intel's 'mainframe on a chip'; with 1.2 million transistors, it is one of the most complex chips ever made
486SX	1991	The chip aimed at bringing mainframe power to the masses; it will eventually make the 80386 obsolete
586	1992	Expected to have 2 million transistors and at least twice the 80486's performance; its mission: to compete with RISC chips
686	1993/1994	Just entering the development phase, the 686 is likely to include sound and video-processing features for 'multimedia'

From *Business Week*, April 29, 1991, p. 55.

and test it in various configurations. How much they can develop prior to the actual appearance of the 586 depends *inter alia* upon the degree of detail of the technological information that they manage to obtain and the extent to which Intel is willing to make them privy of the development process.[25, 26]

On the other hand, coordination attempts can involve substantial informational and reputational costs which can make technology forecasting quite difficult, as revealed for example in the old dispute between IBM and manufacturers of competing mainframe system and 'plug-compatible' peripherals[27] or in the current complaints of software developers against Microsoft.[28]

Clearly, the scope for coordination in the sense outlined above increases with the number and range of AS's (and so does the loss in the case of a failure to coordinate). For example, an improvement in the ability of the PC industry to forecast technological advances in microprocessors may speed up the use of microelectronics in *cars*, fostering larger improvements in cars themselves, stimulating the demand for chips and encouraging their further development, and so forth.[29]

5. Concluding remarks

This paper focuses on the interface between 'key' technologies and the industrial organization of the markets and firms that spring up around them.

[25] It is interesting to note that, dramatically altering its conduct in this respect, Intel has been providing some of its users (such as Compaq) with details of the 586 as it was being developed.

[26] The reverse condition is perhaps less obvious but not less important: to continue with the same example, Intel has been developing parts and circuits for personal computers (other than microprocessors) because '··· through them Intel gains insight into trends: *Knowing what needs to go on a board this year helps it determine what should go into microprocessors next year*' (*Business Week*, April 29, 1991, p. 55). This is true to various degrees as one goes down the 'technological tree': thus, software developers need to actually have the new operating systems in order to develop software for them; in order to write new operating systems one needs to get one's hands on the (new) personal computers that will use them, and so forth.

[27] The latter accused IBM of attempting to delay their innovation efforts through concealment of information about interface standards and uncooperative behavior in establishing market-wide standards (e.g., ASCII vs. EBCDIC) (see Brock, 1975; Fisher et al., 1983).

[28] They claim that Microsoft is less than candid about the features of forthcoming operating systems, thereby delaying efforts to produce complementary applications. In these examples, struggles for market power may have lead to anti-coordination incentives, an idea familiar from the standards literature (see David and Greenstein, 1990). Farrell and Saloner (1986) offer a theory in which there is a social gain to coordinating but rent seeking behavior leads to imperfect outcomes.

[29] This has the flavor of the 'big push' in economic development (see Hirshman, 1960).

What makes them 'key' is their revealed dynamism and pervasiveness, which are endogenous to the system.[30] The goal is to forge a link between the incentives to innovate in GPT-AS's clusters and economic growth, which builds upon the industrial organization details of these markets. Our analysis shows that the unfolding of a GPT gives rise to increasing returns-to-scale, and that this plays an important role in determining the rate of technical advance in the cluster of associated sectors. On the other hand, this same phenomenon makes it difficult for a decentralized economy to fully exploit the growth opportunities offered by an evolving GPT. In particular, if the relationship between the GPT and its users is limited to arms-length market transactions there will be 'too little, too late' innovation in both the GPT and the application sectors. Likewise, difficulties in forecasting technological developments may lower the rate of technical advance of all sectors. Lastly, we have sketched a framework for the empirical analysis of GPT's as they interact with application sectors.

In future work we intend to follow several tracks. First, we would like to conduct empirical studies of GPT's as they evolve over time, interacting with a wide range of using sectors. The starting point would be the dynamic reaction functions in (9) (allowing for a multiplicity of AS's), which can be easily turned into a system of simultaneous equations having as endogenous variables $\dot{z}/z$ and $\dot{T}_a/T_a$ and as exogenous variables demand factors and the rate of advance of 'basic science' (i.e., advances that have a bearing on technical progress in the GPT, but that are not influenced themselves by the GPT). As empirical counterparts of $\dot{z}/z$ and $\dot{T}_a/T_a$ one could use a wide variety of patents measures, as suggested in Trajtenberg et al. (1992). Another possibility would be to use hedonic- based price indices as proxies for $\dot{z}/z$ and $\dot{T}_a/T_a$, but it is doubtful that one could obtain such indices for sufficiently many AS's. The key parameters of interest in such a system would be the slopes of the dynamic reaction functions, which determine the dynamic performance of the GPT-AS's cluster, and hence impact the growth of the whole economy.

Second, we would like to do micro-level studies, aimed at estimating 'technological value added': how much of the gains from innovation registered in markets for final products (i.e., the markets for the AS's) are 'due to' technological advances in the AS's themselves, as opposed to stemming from innovations in the GPT incorporated in the AS's? In our notation the issue is estimating and comparing π_z^a versus π_T^a. We have collected extensive data on microcomputers, which may allow us to carry out this type of study.

Third, we aim to carry out historical studies of GPT's and 'institutions' (in the broad sense): the intention would be to examine the historical evolution of particular GPT's and of the institutions coupled with them, using our

[30] Surely there are more primitive features that attest to the *potential* of some technologies to become GPT's, but so far we have not been able to find a convincing characterization of such features.

conceptual framework in trying to understand their joint dynamics. In particular, we would like to assess the extent to which specific institutions facilitated or hindered the GPT's in playing out their presumed roles as 'engines of growth'. A key hypothesis is that institutions display much more inertia than leading technologies. Thus, as a GPT era comes to a close and new GPT's emerge, an economy may 'get stuck' with the wrong institutions, that is, those that enable the previous GPT to advance and carry the AS's, but that may prove inadequate to do as much for the new GPT.

Appendix 1: Proof of upward-sloping $R^g(T)$

To show that $R^g(T)$ is upward-sloping, we perform the comparative statics exercise implied by maximizing Eq. (6) in the text, for a fixed A:

$$R^g_{T_a} \equiv \frac{\partial z}{\partial T_a} = \beta_1 X^a_{zT_a} + \beta_2 [X^a_{T_a} + (w-c) X^a_{wT}], \tag{10}$$

where

$$\beta_1 = \begin{Vmatrix} (w-c)\Sigma_A X^a_{zz} & \Sigma_A X^a_z + (w-c)\Sigma_A X^a_{zw} \\ \Sigma_A X^a + (w-c)\Sigma_A X^a_{zw} & 2\,\Sigma_A X^a_w + (w-c)\Sigma_A X^a_{ww} \end{Vmatrix}^{-1}$$
$$\times (2\Sigma_A X^a_w + (w-c)\,\Sigma_A X^a_{ww})\,(c, w)$$

and

$$\beta_2 = \begin{Vmatrix} (w-c)\Sigma_A X^a_{ww} & \Sigma_A X^a_z + (w-c)\Sigma_A X^a_{zw} \\ \Sigma_A X^a + (w-c)\,\Sigma_A X^a_{zw} & 2\,\Sigma_A X^a_w + (w-c)\Sigma_A X^a_{ww} \end{Vmatrix}^{-1}$$
$$\times (2\Sigma_A X^a_z + (w-c)\,\Sigma_A X^a_{zw}).$$

If the second-order conditions for a GPT profit maximum hold, our assumptions imply $\beta_1 > 0$, $\beta_2 > 0$, and hence $R^g_{T_a} > 0$. The intuition of this result is easy to see. High T_a in any AS shifts the demand for the GPT good out. The expectation would be, with innovational complementarities, that this raises the private return to investing in z. This argument is not quite complete, however. Since the GPT sector earns its private return through monopoly power, we need a further set of conditions that z and T_a shift marginal revenue in the same direction as the shift in demand – see numerator of β_2 and second term in Eq. (10).

To complete the proof, consider what happens when an additional AS enters. In the case of fixed w, it is immediate that an additional AS increases optimal z. When w is free to vary, the result is implied by our assumptions: add the marginal sector to Eq. (6) with weight λ and differentiate with respect to λ. At $\lambda = 0$, the impact on z is $\beta_1 X^a_z + \beta_2 [X^a + (w-c) X^a_w] > 0$. For $\lambda > 0$, the values of β_1 and β_2 change but are always positive. Thus, adding a sector always increases z.

Appendix 2: Simulations of MPE

Case 1: No adjustment costs

The profit functions are assumed to take the form:[31]

$$\pi_t^a = (d - T_t + z_t)T_t, \tag{11}$$

and similarly,

$$\pi_t^g = (d - z_t + T_t)z_t, \tag{12}$$

where d is a shift parameter common to both. Thus the reaction functions are

$$R^a(z_{t-1}) = b_0 + b_1 z_{t-1},$$

$$R^g(T_{t-1}) = b_0 + b_1 T_{t-1},$$

Solving for MPE renders the following two equations:[32]

$$b_1^4\delta^2 + 2\delta b_1^2 - 2b_1(1+\delta) + 1 = 0, \tag{13}$$

$$b_0(1 - \delta b_1 \delta^2 b_1^2 - \delta^2 b_1^3) = db_1(1+\delta). \tag{14}$$

Given δ one can solve for b_1 in (13), and then, given δ, d, and the corresponding b_1, one can solve for b_0 in (14). We solve for $[b_0, b_1]$ out of this system for different values of the parameter δ and compute the long-term equilibrium values,

$$T^e = z^e = \frac{b_0}{1 - b_1}.$$

As can be seen in (14), d impacts b_0 in a multiplicative fashion, but does not influence b_1; hence $\{z^e, T^e\}$ are just multiples of d, and we can perform all simulations with a single value of d (we picked $d = 100$). The results are shown in Table A.1.

[31] We assume that d is large enough (relative to T and z) so that within the relevant range $\partial\pi^a/\partial T > 0$ and $\partial\pi^g/\partial z > 0$. For convenience we omit here the subindex a in the T's.

[32] Comparing this case (with $\pi_{zt} > 0$ and hence a positive b_1) to the one examined by M&T, one can see that our Eq. (13) is identical to their Eq. 20, but our Eq. (14) differs from their Eq. 21.

Table A.1
Simulations of MPE

Case 1: Without adjustment costs ($d = 100$)

δ	b	a	$z^e(\delta) = T^e(\delta)$
0.1	0.475	55.1	105
0.2	0.451	60.3	110
0.3	0.428	65.6	115
0.4	0.406	71.0	120
0.5	0.384	76.2	124
0.6	0.364	81.4	128
0.7	0.345	86.3	132
0.8	0.327	91.1	135
0.9	0.311	95.7	139

Case 2: With adjustment costs ($d = 100$)

	$z^e(\delta, \alpha) = T^e(\delta, \alpha)$		
δ	$\alpha = 1$	$\alpha = 10$	$\alpha = 100$
0.1	103.4	100.9	100.1
0.2	107.0	102.0	100.3
0.3	110.8	103.4	100.5
0.4	115.0	105.3	100.8
0.5	119.3	107.9	101.2
0.6	123.8	111.4	102.0
0.7	128.6	116.4	103.7
0.8	133.3	123.3	107.5
0.9	138.1	132.5	117.4

Case 2: With adjustment costs

The profit functions are the same as in (11) and (12), except that we subtract from them the adjustment costs $A^a = (\alpha/2)(T_t - T_{t-1})^2$ for the AS and $A^g = (\alpha/2)(z_t - z_{t-1})^2$ for the GPT sector. The corresponding reactions functions are

$$R^a(z_{t-1}, T_{t-2}) = b_0 + b_1 z_{t-1} + b_2 T_{t-2},$$

$$R^g(T_{t-1}, z_{t-2}) = b_0 + b_1 T_{t-1} + b_2 z_{t-2}.$$

The first-order condition is[33]

[33] Jean Tirole informed us in a personal communication that the FOC as shown in Eq. 30 of their published paper (Maskin and Tirole, 1987) is missing terms, and he kindly made available to me an unpublished corrigendum with the correct equation, which is the one shown here, adapted to our case.

$$\pi_z^g(z_t, T_{t-1}) - \frac{\partial A^g}{\partial z_t}(z_t, z_{t-2}) + \delta[\pi_z^g(z_t, T_{t+1}) + \pi_T^g(z_t, T_{t+1})]\frac{\partial R^a}{\partial z_t}(z_t, T_{t-1})$$

$$+ \delta^2[-\pi_z^g(z_{t+2}, T_{t+1})\beta + \pi_T^g(z_{t+2}, T_{t+1})]\frac{\partial R^a}{\partial z_t}(z_t, T_{t+1})$$

$$-\frac{\partial A^g}{\partial z_t}(z_{t+2}, z_t) + \beta\frac{\partial A^g}{\partial z_{t+2}}(z_{t+2}, z_t) + \delta^3[-\pi_z^g(z_{t+2}, T_{t+3})\beta]$$

$$+ \delta^4\left[\frac{\partial A^g}{\partial z_{t+2}}(z_{t+4}, z_{t+2})\beta\right] = 0.$$

Using the software program 'Mathematica' we derived from (15) the three equations in the three unknowns $[b_0, b_1, b_2]$, solve for them for different sets of values of the parameters $\{\delta, d, \alpha\}$, and compute the long-term equilibrium

$$T^e = z^e = \frac{b_0}{1 - b_1 - b_2}.$$

As in the case without adjustment costs, d impacts b_0 in a multiplicative fashion but does not influence b_1 and b_2; hence $\{z^e, T^e\}$ are multiples of d, and we can perform all simulations with a single value of d. Table A.1 shows the results of the simulations for $\alpha = 1, 10, 100$ and $\delta\varepsilon(0.1, 0.9)$ in intervals of 0.1.

References

Abramovitz, M., 1956, Resource and output trends in the United States since 1870, American Economic Review Papers and Proceedings 46, 5–23.

Arrow, K.J., 1962, Economic welfare and the allocation of resources for inventions, in: R. Nelson, ed., The rate and direction of inventive activity (Princeton University Press, Princeton, NJ) 609–625.

Bolton, P. and M.D. Whinston, 1993, Incomplete contracts, vertical integration, and supply constraints, Review of Economic Studies 60, 121–148.

Bresnahan, T. and M. Trajtenberg, 1992, General purpose technologies: Engines of growth?, NBER working paper no. 4148.

Brock, Gerald W., 1975, U.S. computer industry: A study in market power (Ballinger, Cambridge, MA).

Bulow, J., J. Geanakoplos, and P. Klemperer, 1985, Multimarket oligopoly: Strategic substitutes and complements, Journal of Political Economy 93, 488–511.

Cooper, R. and A. John, 1988, Coordination failures in Keynesian models, Quarterly Journal of Economics 103, 441–463.

Dana, R.A. and L. Montrucchio, 1986, Dynamic complexity in duopoly games, Journal of Economic Theory 40, 40–56.

Dana, R.A. and L. Montrucchio, 1987, On rational dynamic strategies in infinite horizon models where agents discount the future, Journal of Economic Behavior and Organization 8, 497–511.

David, P.A., 1990, The dynamo and the computer: An historical perspective on the modern productivity paradox, American Economic Review Papers and Proceedings, 355–361.

David, Paul A. and Shane Greenstein, 1990, The economics of compatibility standards: An introduction to recent research, Economics of Innovation and New Technology 1, 3–41.

Farrell, Joseph and Garth Saloner, 1986, Installed base and compatibility: Innovation, product preannouncements, and predation, American Economic Review 76, 940–955.

Fisher, F.M., J.E. Greenwood, and J.J. McGowan, 1983, Folded, spindled, and mutilated: Economic analysis of U.S. vs. IBM (MIT Press, Cambridge, MA).

Griliches, Z., 1957, Hybrid corn: An exploration in the economics of technological change, Econometrica 25, 501–522.

Griliches, Z., 1958, Research costs and social returns: Hybrid corn and related innovations, Journal of Political Economy 66, 419–431.

Griliches, Z., ed., 1984, R&D, patents, and productivity (University of Chicago Press, Chicago, IL).

Griliches, Z., 1988, Technology, education, and productivity (Basil Blackwell, New York, NY).

Griliches, Z. and V. Ringstad, 1971, Economies of scale and the form of the production function (North-Holland, Amsterdam).

Grossman, G.M. and E. Helpman, 1991, Innovation and growth in the global economy (MIT Press, Cambridge, MA).

Hart, O., 1988, Incomplete contracts and the theory of the firm, Journal of Law, Economics and Organization 4, 119–139.

Hirshman, A.O., 1960, The strategy of economic development (Yale University Press, New Haven, CT).

Holmstrom, B., 1982, Moral hazard in teams, Bell Journal of Economics 13, 324–340.

Landes, D., 1969, The unbound Prometheus (Cambridge University Press, Cambridge).

Maskin, E. and J. Tirole, 1987, A theory of dynamic oligopoly, III: Cournot competition, European Economic Review 31, 947–968.

Milgrom, P. and J. Roberts, 1990, Rationalizability, learning and equilibrium in games with strategic complementarities, Econometrica 58, 1255–1277.

Milgrom, P., Y. Qian, and J. Roberts, 1991, Complementarities, Momentum, and the evolution of modern manufacturing, American Economic Review, 84–88.

Mokyr, J., 1990, The lever of riches (Oxford University Press, New York, NY).

Murphy, K.M., A. Shleifer, and R.W. Vishny, 1989, Industrialization and the big push, Journal of Political Economy 97, 1003–1026.

Pakes, A. and P. McGuire, 1992, Computation of Markov perfect Nash equilibrium: Numerical implications of a dynamic differentiated product model, NBER technical discussion paper.

Romer, P., 1986, Increasing returns and long-run growth, Journal of Political Economy 94, 1002–1037.

Rosenberg, N., 1982, Inside the black box: Technology and economics (Cambridge University Press, Cambridge).

Spence, M., 1975, Monopoly, quality and regulation, Bell Journal of Economics 6, 417–429.

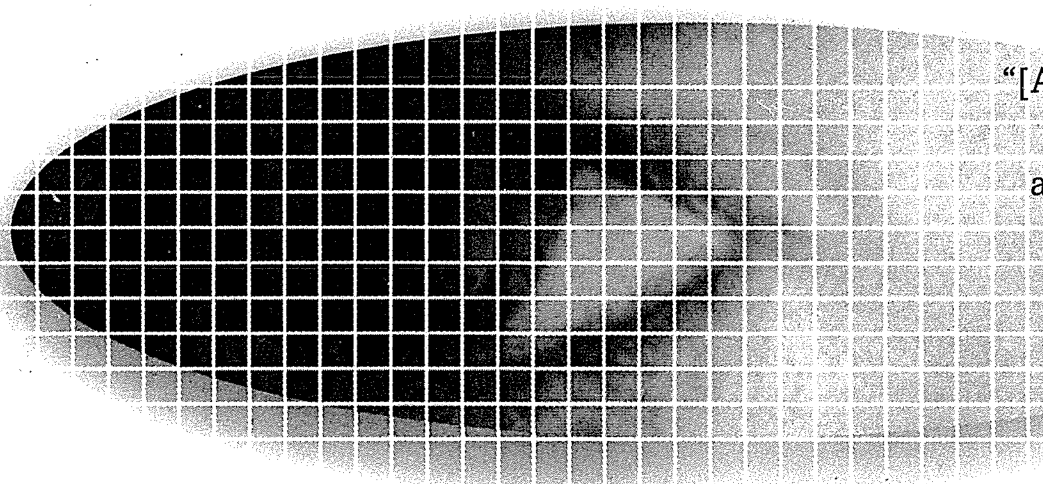
Solow, R., 1957, Technical change and the aggregate production function, Review of Economics and Statistics 39, 312–320.

Tirole, J., 1988, The theory of industrial organization (MIT Press, Cambridge, MA).

Trajtenberg, M., R. Henderson, and A. Jaffe, 1992, Ivory tower versus corporate lab: An empirical study of basic research and appropriability, NBER working paper no. 4146.

Weaving the Web

The Original Design and Ultimate Destiny of the World Wide Web



"[An] important account of how, when, where, and why [Berners-Lee] cooked up the web—well worth reading."
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Foreword by MICHAEL DERTOUZOS, *Director of MIT Laboratory for Computer Science*

TIM BERNERS-LEE

I began to re-create Enquire on the Compaq. I wrote the program so that it would run on both the luggable Compaq and the VAX minicomputer made by DEC that I was using at CERN. I didn't do such a good job the second time around, though: I just programmed in the internal links, and never got around to writing the code for the external links. This meant that each web was limited to the notes that would fit in one file: no link could connect those closed worlds. The debilitating nature of this restriction was an important lesson.

It was clear to me that there was a need for something like Enquire at CERN. In addition to keeping track of relationships between all the people, experiments, and machines, I wanted to access different kinds of information, such as a researcher's technical papers, the manuals for different software modules, minutes of meetings, hastily scribbled notes, and so on. Furthermore, I found myself answering the same questions asked frequently of me by different people. It would be so much easier if everyone could just read my database.

What I was looking for fell under the general category of *documentation systems*—software that allows documents to be stored and later retrieved. This was a dubious arena, however. I had seen numerous developers arrive at CERN to tout systems that "helped" people organize information. They'd say, "To use this system all you have to do is divide all your documents into four categories" or "You just have to save your data as a WordWonderful document" or whatever. I saw one protagonist after the next shot down in flames by indignant researchers because the developers were forcing them to reorganize their work to fit the system. I would have to create a system with common rules that would be acceptable to everyone. This meant as close as possible to no rules at all.

This notion seemed impossible until I realized that the diversity of different computer systems and networks could be a rich resource—something to be represented, not a problem to be eradicated. The model I chose for my minimalist system was hypertext.

My vision was to somehow combine Enquire's external links with hypertext and the interconnection schemes I had developed for RPC. An Enquire program capable of external hypertext links was the difference between imprisonment and freedom, dark and light. New webs could be made to bind different computers together, and all new systems would be able to break out and reference others. Plus, anyone browsing could instantly add a new node connected by a new link.

The system had to have one other fundamental property: It had to be completely decentralized. That would be the only way a new person somewhere could start to use it without asking for access from anyone else. And that would be the only way the system could scale, so that as more people used it, it wouldn't get bogged down. This was good Internet-style engineering, but most systems still depended on some central node to which everything had to be connected—and whose capacity eventually limited the growth of the system as a whole. I wanted the act of adding a new link to be trivial; if it was, then a web of links could spread evenly across the globe.

So long as I didn't introduce some central link database, everything would scale nicely. There would be no special nodes, no special links. Any node would be able to link to any other node. This would give the system the flexibility that was needed, and be the key to a universal system. The abstract document space it implied could contain every single item of information accessible over networks—and all the structure and linkages between them.

Hypertext would be most powerful if it could conceivably point to absolutely anything. Every node, document—whatever it was called—would be fundamentally equivalent in some way. Each would have an address by which it could be referenced. They would all exist together in the same space—the information space.

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NETWORK NEUTRALITY AND THE FALSE PROMISE OF ZERO-PRICE REGULATION

C. Scott Hemphill †

This Article examines zero-price regulation, the major distinguishing feature of many modern "network neutrality" proposals. A zero-price rule prohibits a broadband Internet access provider from charging an application or content provider (collectively, "content provider") to send information to consumers. The Article differentiates two access provider strategies thought to justify a zero-price rule. Exclusion *is anticompetitive behavior that harms a content provider to favor its rival.* Extraction *is a toll imposed upon content providers to raise revenue. Neither strategy raises policy concerns that justify implementation of a broad zero-price rule. First, there is no economic exclusion argument that justifies the zero-price rule as a general matter, given existing legal protections against exclusion. A stronger but narrow argument for regulation exists in certain cases in which the output of social producers, such as Wikipedia, competes with ordinary market-produced content. Second, prohibiting direct extraction is undesirable and counterproductive, in part because it induces costly and unregulated indirect extraction. I conclude, therefore, that recent calls for broad-based zero-price regulation are mistaken.*

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Introduction

The modern debate about regulatory policy in telecommunications elicits a powerful sense of déjà vu. Recent proposals for "network neutrality" regulation echo and invoke common carriage, the regulatory regime often applied to railroads, telecommunications, and other infrastructural industries. The central requirement of common carriage is that the carrier must offer its services in a nondiscriminatory fashion.[1] Network neutrality, like common carriage, responds to a concern that the owner of a bottleneck facility—here, a

1 For an introduction to nondiscrimination norms in common carrier regulation, see Joseph D. Kearney & Thomas W. Merrill, *The Great Transformation of Regulated Industries Law*, 98 COLUM. L. REV. 1323, 1330-40 (1998). For arguments that network neutrality is simply a replay of common carriage, see *infra* note 18 and accompanying text.

broadband Internet access provider—will discriminate among users of the facility in a socially undesirable fashion.[2] The users at issue are a wide range of content and application providers, from YouTube and Yahoo to firms such as Vonage that provide telephone service over a broadband connection, users that I refer to collectively as "content providers."

The analogy to common carriage, however, is imperfect. Network neutrality departs from the traditions of common carriage in an important respect. Many (though not all) network neutrality proposals share a distinctive feature, what I call a *zero-price rule*. A zero-price rule prohibits an access provider from charging content providers to send information to consumers.[3] For example, access provider AT&T may not charge video content provider YouTube for access to AT&T's customers, even if AT&T makes the same offer to YouTube rivals such as iFilm. A zero-price rule has significant economic consequences due to the emergent capacity of an access provider to control the ability of content providers to reach broadband customers.[4] Requiring a uniform, zero price exceeds the restrictions of common carriage, which tolerates some forms of price discrimination in which an offer available to one purchaser is also available to others.

This Article poses and answers a single question: can zero-price regulation of broadband access providers be justified on economic grounds? The first step of the analysis is to distinguish two access provider strategies that might justify the rule. These strategies are not unique to broadband access providers, but are available generally to any provider of a platform—that is, a foundational technology such as broadband access, the electric grid, or a video game console, used in combination with particular complementary applications to deliver value to consumers.[5] The analysis presented here thus provides insight into the broader question of optimal regulation of platforms.

The first platform strategy is exclusion: actions taken to impair an application's success relative to its rival. For example, in exchange for compensation from YouTube, AT&T might favor YouTube over iFilm in order to induce iFilm's exit. The second strategy is extraction: a platform's *threat* of

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2 For a useful summary of the debate, see Jon M. Peha et al., *The State of the Debate on Network Neutrality*, 1 INT'L J. COMM. 709 (2007).

3 The content provider makes payments for transport but makes no incremental payment to the consumer's broadband provider. *See infra* Section I.A for further discussion.

4 *See* FTC, BROADBAND CONNECTIVITY COMPETITION POLICY 30-31 (2007), *available at* http://www.ftc.gov/reports/broadband/v070000report.pdf [hereinafter FTC STAFF REPORT] (describing packet inspection and "flow classification" technologies that enable inferences about packet type and source); ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, INTERNET TRAFFIC PRIORITISATION: AN OVERVIEW (2007), *available at* http://www.oecd.org/dataoecd/43/63/38405781.pdf (discussing tools to inspect packets, discern their type, and prioritize their delivery).

5 For related definitions of a platform, see Timothy F. Bresnahan & Shane Greenstein, *Technological Competition and the Structure of the Computer Industry*, 47 J. INDUS. ECON. 1 (1999); Annabelle Gawer & Rebecca Henderson, *Platform Owner Entry and Innovation in Complementary Markets: Evidence from Intel*, 16 J. ECON. & MGMT. STRATEGY 1 (2007); Jean-Charles Rochet & Jean Tirole, *Two-Sided Markets: A Progress Report*, 37 RAND J. ECON. 645 (2006).

exclusion, made to all applications in order to expropriate a share of application profits. For example, AT&T might insist upon payments from both YouTube *and* iFilm in exchange for premium access.

Both exclusion and extraction rely upon the platform's ability to control access to its consumers, but differ in the use to which that power is put. A platform's incentive to extract, unlike its incentive to exclude, is premised upon application success, because successful applications present a larger opportunity for extraction. Extraction entails a threat of exclusion, but the threat is unlikely to be implemented because the parties will reach a bargain instead. Extraction is a form of private taxation that aims to raise revenue, rather than—as with exclusion—taxation to deter disfavored behavior. Although the separation is imperfect, exclusion is a preoccupation of antitrust policy. Extraction is not generally a subject of antitrust, but it is a central concern of innovation policy because the transfer of resources from applications to the platform may alter the prospective incentives of each to invest in innovation.

One contribution of this Article is to untangle exclusion and extraction as distinct bases for zero-price regulation. These differences are frequently ignored, producing an unfortunate conflation of justifications for regulation. Separating the two permits a reframing of the key question: to what extent do exclusion or extraction concerns justify the imposition of a zero-price rule upon access providers? To answer that question, the present analysis focuses attention on key elements of industry economics, such as fragmentation in the access provider market, nonfinancial incentives to develop content, and market interactions among content providers, consumers, and access providers that undo the effect of a regulatory intervention.

An initial result is that exclusion concerns provide no general justification for a zero-price rule. Much anticompetitive exclusion is already prohibited by existing antitrust law. To the extent that antitrust law as currently enforced successfully identifies and remedies exclusion, there is less need for a new layer of regulatory intervention. A zero-price rule is also overinclusive, relative to concerns about exclusion. Thus, advocates who rely upon exclusion to justify broad zero-price rules are mistaken.

There is a relatively stronger argument for zero-price regulation, however, in the narrower case of socially produced content—that is, content such as the online encyclopedia Wikipedia, produced when individuals collaborate without anticipation of financial reward.[6] Socially produced content raises distinctive issues for regulatory policy where such content competes with ordinary market-produced content. For example, Wikipedia vies with market competitors such as Encyclopedia Britannica for the attention of broadband customers. Exclusion of social production is a source of inefficiency that antitrust law is unlikely to

6 *See* YOCHAI BENKLER, THE WEALTH OF NETWORKS: HOW SOCIAL PRODUCTION TRANSFORMS MARKETS AND FREEDOM 59-90 (2006) (describing social production of content).

remedy. Reducing that inefficiency is a possible, albeit narrower, mission for zero-price regulation.

Extraction concerns fare no better, in general, as a justification for a zero-price rule. Zero-price rules have a serious practical problem. Although an access provider is prohibited from charging *content providers*, it is free to charge *consumers* under the leading network neutrality proposals. As a result, the access provider may charge the consumer for premium service—prompt delivery of video, for example—in the expectation that the content provider, in turn, will compensate the consumer for the extra expense. When indirect extraction replaces (prohibited) direct extraction, private bargaining tends to undo the effect of the government regulation. The shift to indirect extraction also imposes a social cost, making a ban on direct extraction not only ineffective, but counterproductive as well.

Extraction is a doubtful basis for a zero-price rule for other reasons. Internet content is often developed for reasons other than the expectation of profit. To the extent that nonfinancial motivations spur content development, extraction matters less for content development than is generally assumed. Moreover, consumer usage of broadband service may create significant benefits that are not captured by the access provider or content provider. An access provider strategy to charge content providers, while subsidizing consumers with low financial willingness to pay, could increase adoption and thereby increase these benefits. This attractive strategy is forbidden by a zero-price rule. In sum, neither exclusion nor extraction concerns justify a broad zero-price rule.

Part I of this Article defines a zero-price rule, distinguishes exclusion- and extraction-based justifications for zero-price regulation, and identifies several harms that have resulted from the conflation of these justifications. Part II considers and rejects exclusion as a justification for a generally applicable zero-price rule, while identifying a stronger argument for narrowly focused regulation where socially produced content competes with market production. Part III explains why extraction concerns provide no clear justification for a zero-price rule. Part IV concludes.[7]

7 To focus attention on the issues discussed in the text, much is omitted. This Article is not a comprehensive treatment of common carriage, platform economics, or network neutrality. For example, I focus upon the scope of substantive prohibition but do not venture far into the relative institutional merits of ex ante regulation and ex post antitrust intervention. For an introduction to this debate, compare PETER HUBER, LAW AND DISORDER IN CYBERSPACE 3-9 (1997) (advocating abolition of FCC and maintenance of competition through common law, particularly antitrust law), with Robert D. Atkinson & Philip J. Weiser, *A Third Way on Network Neutrality*, NEW ATLANTIS, Summer 2006, at 47, 56 (advocating FCC oversight of competition). *See also* Joseph Farrell, *Open Access Arguments: Why Confidence Is Misplaced, in* NET NEUTRALITY OR NET NEUTERING: SHOULD BROADBAND INTERNET SERVICES BE REGULATED? 195, 206 (Thomas M. Lenard & Randolph J. May eds., 2006) (noting the difficulty of ex post antitrust intervention); Howard A. Shelanski, *Adjusting Regulation to Competition: Toward a New Model for U.S. Telecommunications Policy*, 24 YALE J. ON REG. 55, 101-02 (2007) (favoring ex post, targeted enforcement over ex ante regulation). I mention but do not dwell upon certain effects of price discrimination whose applicability is contested in this context—for example, that if a

I. Justifying Zero-Price Regulation

A. *An Example: The AT&T Merger Condition*

In 2006, AT&T announced its plan to acquire BellSouth, the latest step in a continuing consolidation among local telephone companies.[8] In addition to providing ordinary telephone service, the merged entity possessed a substantial broadband access business. The Antitrust Division of the Department of Justice approved the deal without imposing any conditions.[9] The Federal Communications Commission (FCC), whose approval was also required, took a different approach. Two commissioners with a collective veto over the AT&T-BellSouth transaction,[10] Commissioners Adelstein and Copps, obliged the parties to accept a network neutrality condition in December 2006. An examination of the merger condition and the justifications given by the FCC commissioners highlights a leading form of network neutrality regulation, namely zero-price regulation, and the disparate ends it is thought to serve.

1. Means: Zero-Price Regulation

The AT&T merger condition is a zero-price rule in the sense discussed in the introduction. It forbids AT&T to "provide" or "sell" to content providers "any service that privileges, degrades or prioritizes any packet . . . based on its source, ownership or destination."[11] Thus, AT&T may not sell, in addition to the "best-efforts" service that characterizes ordinary Internet access provision, a distinct high-quality offering providing access to (say) YouTube—for example, service with less transmission delay ("latency") or variation in transmission speed ("jitter"), qualities that are useful for delivering real-time

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tailored offering is prohibited, output might fall, and that price discrimination is a useful tool for efficiently managing congestion. Noneconomic justifications for regulation, including the First Amendment and equality norms, are slighted too. *Compare* Bill D. Herman, *Opening Bottlenecks: On Behalf of Mandated Network Neutrality*, 59 FED. COMM. L.J. 107, 116-23 (2006) (advocating neutrality as means to diversify editorial control), *with* Christopher S. Yoo, *Network Neutrality and the Economics of Congestion*, 94 GEO. L.J. 1847, 1905-08 (2006) (opposing neutrality as interference with editorial discretion).

8 *See* Bell Atl. Corp. v. Twombly, 127 S. Ct. 1955, 1961-62 & n.1 (2007) (describing creation and consolidation of incumbent local exchange carriers).

9 Press Release, U.S. Dep't of Justice, Statement by Assistant Attorney General Thomas O. Barnett Regarding the Closing of the Investigation of AT&T's Acquisition of BellSouth (Oct. 11, 2006), *available at* http://www.usdoj.gov/atr/public/press_releases/2006/218904.pdf.

10 The approval of a majority of the five-member Commission was required, and after one commissioner withdrew from consideration of the merger, *see* Jim Puzzanghera, *FCC Approves AT&T Merger*, L.A. TIMES, Dec. 30, 2006, at C1, Commissioners Copps and Adelstein collectively held a blocking veto.

11 Letter from Robert W. Quinn, Jr., Senior Vice President, AT&T Servs., Inc., to Marlene H. Dortch, Sec'y, FCC 8 (Dec. 28, 2006), *available at* http://www.fcc.gov/ATT_FINALMerger Commitments12-28.pdf [hereinafter AT&T Merger Condition].

video content.[12] Aside from prohibiting AT&T from making a premium deal with YouTube alone, the merger condition prohibits AT&T from making a premium offer generally available to all video content providers—that is, not only to YouTube but also to its rivals, such as iFilm.[13] In fact, AT&T is barred even from charging all content providers a uniform, fixed fee.[14]

To be clear, even if a content provider is insulated from the access payments that are the subject of this Article, the content provider must pay its own access provider for connectivity.[15] Thus, a zero-price rule imposes a zero price only as to the incremental charge made by the consumer's access provider to connect a particular content provider with the consumer.

The imposition of a zero, uniform price crosses the traditional boundaries of common carriage. Common carriage is a frequent source of analogies and reasoning for modern telecommunications policy.[16] Because access providers are not subject to common carrier rules,[17] it is natural to ask whether common-carrier regulation should extend to access provision. Some commentators view network neutrality as a replay of the common carriage debate.[18]

The price uniformity implemented by a zero-price rule, however, is not a condition of common carriage. Common carriers have long been permitted to

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12 An access provider might exercise control by blocking certain content entirely, or instead by altering its speed, latency, or jitter. For some types of content, only a block will have an economic effect. The present analysis is insensitive to the precise method used to impose the relative disadvantage, and ventures no view about whether blocking raises additional concerns on noneconomic grounds, such as the First Amendment. *Cf.* Red Lion Broad. Co. v. FCC, 395 U.S. 367, 392 (1969) (affirming FCC policy designed to prevent "private censorship").

13 Such an offer, if accepted, would "privilege" service based upon a packet's "source." AT&T Merger Condition, *supra* note 11, at 8. The condition applies to offers made to AT&T subsidiaries and lasts for two years or until Congress passes network neutrality legislation, whichever comes first. AT&T's willingness to accept a relatively short-lived restriction may reflect a calculation that discrimination is not yet fully practicable.

14 Charging a provider for basic service would once again "privilege" service based upon a packet's "source." *See id.*

15 *See, e.g.*, Lawrence Lessig, Address at the American Enterprise Institute: Key Issues in Telecommunications Policy 29:50 (May 10, 2006), *available at* http://app2.capitalreach.com/esp1204/servlet/tc?cn=aei&c=10162&s=20272&e=2921&&espmt=2 [hereinafter Lessig AEI Presentation] (noting content provider payments for connectivity).

16 *See generally* ITHIEL DE SOLA POOL, TECHNOLOGIES OF FREEDOM (1983).

17 *See* Nat'l Cable & Telecomms. Ass'n v. Brand X Internet Servs., 545 U.S. 967 (2005) (affirming FCC determination that cable modem access is not telecommunications service subject to common carrier requirements); *In re* Appropriate Framework for Broadband Access to the Internet over Wireline Facilities, 20 F.C.C.R. 14,853 (2005) (forbearing to impose common carrier requirements upon DSL broadband access providers, despite their status as a telecommunications service).

18 *See, e.g.*, Bruce Owen, *The Net Neutrality Debate: Twenty Five Years After United States v. AT&T and 120 Years After the Act to Regulate Commerce* 4 & n.6 (Stanford Law & Econ. Olin Working Paper No. 336, 2007), *available at* http://ssrn.com/abstract=963623 (describing net neutrality as a "semantically unnecessary term for the old ide[a] 'common carrier access'"); Christian Sandvig, *Network Neutrality Is the New Common Carriage*, 9 J. POL'Y, REG. & STRATEGY 136 (2007); *Moyers on America: The Net at Risk* (PBS television broadcast Oct. 18, 2006) (transcript available at http://www.pbs.org/moyers/moyersonamerica/print/netatrisk_transcript_print.html) (quoting Rick Karr, reporter for documentary; "The Internet version of common carriage is known as 'network neutrality.'").

engage in price discrimination. Historically, for example, railroads have charged a higher price to shippers of high-value materials,[19] as part of value-of-service ratemaking.[20] Telephone companies charged higher rates to business customers and in large cities.[21] And highly tailored service packages for large business customers have been held to satisfy the Communication Act's nondiscrimination rule,[22] provided the filed tariff is available to other customers with the same needs.[23] Common carriage merely prohibits certain types of unreasonable discrimination.[24] Network neutrality therefore adds an additional element—insistence upon a zero, uniform price—to the traditional regulatory principles of nondiscrimination and interconnection.

Though not a requirement of common carriage, some regulatory regimes do implement a zero-price rule. The Carterfone attachment regime permitted independent equipment manufacturers to offer new attachments to the AT&T network without permission from or payment to AT&T.[25] "Must-carry" rules require cable television providers to carry local television broadcasts without payment.[26] Zero-price outcomes are implemented outside the context of communications as well. For example, the owners of the electric grid charge end users but not appliance manufacturers, though this appears to be a matter of technical feasibility rather than the result of any legal rule.

A zero-price rule is a key tenet of network neutrality advocacy. Aside from the AT&T merger condition, it is a common feature of proposed

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19 *See, e.g.*, JAMES C. BONBRIGHT, PRINCIPLES OF PUBLIC UTILITY RATES 83 (1961) (railroad rates vary depending upon value of commodity shipped, out of proportion to difference in cost).

20 *See id.* at 372 (describing Interstate Commerce Commission approval of value-of-service ratemaking despite discriminatory effect). One source of confusion has been use of the term "discrimination" to denote only *actionable* discrimination. *Id.* at 371-72.

21 *Id.* at 83; 1 ALFRED E. KAHN, THE ECONOMICS OF REGULATION: PRINCIPLES AND INSTITUTIONS 63-64 (1970).

22 47 U.S.C. § 202(a) (2000) (prohibiting "unjust or unreasonable discrimination").

23 For example, AT&T's Tariff 12. *See* Competitive Telecomms. Ass'n v. FCC, 998 F.2d 1058, 1063 (D.C. Cir. 1993) ("[I]f the package is made available to any customer who wants it upon the same terms, then there is no unlawful discrimination."); *see also* Sea-Land Serv., Inc. v. ICC, 738 F.2d 1311, 1317 (D.C. Cir. 1984) ("Although one normally regards contract relationships as highly individualized, contract rates can still be accommodated to the principle of nondiscrimination by requiring a carrier offering such rates to make them available to any [customer] willing and able to meet the contract's terms.").

24 *See* BONBRIGHT, *supra* note 19, at 370 (only "undue" or "unjust" discrimination prohibited); Eli M. Noam, *Beyond Liberalization II: The Impending Doom of Common Carriage*, 18 TELECOMM. POL'Y 435, 436 (1994) ("[N]o customer seeking service upon reasonable demand, willing and able to pay *the established price, however set*, would be denied lawful use of the service or would otherwise be discriminated against.") (emphasis added); *id.* at 438 (noting that limitations on discrimination are not absolute); *see also* James B. Speta, *A Common Carrier Approach to Internet Connection*, 54 FED. COMM. L.J. 225, 258 (2002) (noting the weakness of the nondiscrimination obligation at common law).

25 Provided the attachment meets certain minimum technical requirements. *In re* Use of the Carterfone Device in Message Toll Tel. Servs., 13 F.C.C.2d 420 (1968), *reconsideration denied*, 14 F.C.C.2d 571 (1968).

26 47 U.S.C. §§ 534, 535 (2000) (cable); *see also id.* § 338(a)(1) (Supp. V 2005) (similar for direct broadcast satellite operators).

legislative solutions,[27] academic advocacy,[28] and corporate lobbying by content providers such as Google.[29] Opponents of network neutrality have identified it as a troubling feature of regulatory proposals.[30]

Not all network neutrality proponents insist upon a zero-price rule. Others, including Lawrence Lessig[31] and a senior Google executive (dissenting from the firm's official position),[32] appear to accept access fees imposed upon content providers, provided that an offer made to one content provider is also extended to its rivals.[33]

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27 In early 2007, Senator Dorgan introduced the Internet Freedom Preservation Act, which would amend the Communications Act to impose a zero-price rule. S. 215, 110th Cong. § 2 (2007) (adding a new section 12(a)(4)(C) to the Communications Act, imposing a duty upon carriers to enable application access on a basis that does not impose a charge on the basis of application type). In the 109th Congress, at least three bills employed a zero-price rule. Representative Sensenbrenner introduced the Internet Freedom and Nondiscrimination Act of 2006, which would have amended the Clayton Act to require an access provider to prioritize all data of a specific type, regardless of origin of ownership, if it did so for any data of that type, and without charging, and to provide nonaffiliated applications with the same quality (again without a charge) as that provided to affiliates. H.R. 5417, 109th Cong. § 3 (2006). The Network Neutrality Act of 2006, introduced by Representative Markey, would have imposed a similar duty. H.R. 5273, 109th Cong. § 4(a)(7) (2006) ("[If a] broadband network provider prioritizes . . . data of a particular type, [then it must] prioritize . . . all data of that type (regardless of [origin]) without imposing a surcharge . . . ."). Of similar import was the Internet Non-Discrimination Act of 2006 introduced by Senator Wyden. S. 2360, 109th Cong. § 4(a)(3) (2006) ("[A] network operator shall . . . not assess a charge to any application or service provider not on the network of such operator for the delivery of traffic to any subscriber to the network of such operator . . . .").

28 FTC, Broadband Connectivity Competition Policy Workshop 259-60 (Feb. 14, 2007), *available at* http://www.ftc.gov/opp/workshops/broadband/transcript_070214.pdf (statement of Tim Wu) (arguing in favor of zero-price regulation).

29 Posting of Richard Whitt, Washington Telecom and Media Counsel, to Google Public Policy Blog, http://googlepublicpolicy.blogspot.com/2007/06/what-do-we-mean-by-net-neutrality.html (June 16, 2007, 17:52 EST) (advocating ban on "surcharges on content providers that are not [the access provider's] retail customers").

30 *See, e.g.*, Hal J. Singer, *Net Neutrality: A Radical Form of Non-Discrimination*, REG., Summer 2007, at 36; Robert W. Hahn & Robert E. Litan, *The Myth of Network Neutrality and What We Should Do About It* 8-9 (AEI-Brookings Joint Ctr. for Regulatory Studies, Working Paper No. RP06-33, 2006), *available at* http://www.aei-brookings.org/admin/authorpdfs/page.php?id=1357.

31 *See, e.g.*, Lessig AEI Presentation, *supra* note 15, at 1:04:20 (answering, in response to question, that charging Google and rival the same amount would not raise application tiering issues); *id.* at 58:30 (stating that only concern is viewpoint discrimination); Lawrence Lessig, Lecture at Center for American Progress, The Withering of the Net: How D.C. Pathologies Are Undermining the Growth and Wealth of the Net 14 (June 16, 2006) (transcript available at http://www.americanprogress.org/kf/060616%20lessig%20lecture.pdf) (accepting practice where access provider charges rival content providers same premium price for video transport).

32 Google Senior Policy Counsel Andrew McLaughlin distinguished zero-price regulation, Google's official position, from a "more pragmatic view that it is OK [to charge] as long as it is done in a non-discriminatory way." *See* Posting of Drew Clark to GigaOM, *Is Google Changing Its Position on Net Neutrality?*, http://gigaom.com/2007/03/13/is-google-changing-its-position-on-net-neutrality (Mar. 13, 2007). A Google spokesperson later reaffirmed that McLaughlin's view differed from Google's. *Id.*

33 One observer has concluded that "[m]ost recently, network neutrality proponents have conceded the validity of access tiering and have simply argued for nondiscrimination within tiers." Christopher S. Yoo, *What Can Antitrust Contribute to the Network Neutrality Debate?*, 1 INT'L J. COMM. 493, 518 (2007). No evidence is cited in support of this conclusion, which seems too strong given the examples discussed in this section. Such a concession by network neutrality advocates, moreover, implies a rejection of the AT&T merger condition, a condition that at least some network neutrality advocates applaud. The assertion also overlooks those advocates for whom a zero-price rule

2. Ends: "Anticompetitive Discrimination" and "Toll Booths"

Commissioner Adelstein issued a statement explaining why he had insisted upon a network neutrality condition, and Commissioner Copps did the same. Adelstein decried the parties' incentives for "anti-competitive discrimination"[34] and understood the imposition of network neutrality as a way to prevent an access provider from acting upon that incentive. He chastised the Antitrust Division for what he viewed as its failure to act and argued that the Division's inactivity had made FCC action necessary.[35] Put differently, he saw the Division's decisionmaking, and the FCC's, within an antitrust frame. The antitrust frame Adelstein apparently had in mind is a concern about exclusion—to return to the earlier example, that AT&T, in exchange for payment, might favor YouTube over iFilm.

Copps took a different view. For Copps, the provision's value was to "ensure[]" that content providers and other Internet users "have the ability to reach the merged entities' millions of Internet users—without seeking the company's permission or paying it a toll."[36] To worry about tolls is to worry about extraction, the use of a threat of exclusion to insist upon a share of content providers' profits. To be sure, Copps' statement did not rule out a concern about exclusion. A toll might be undesirable because the price is set so high that it deters a rival's entry. "Permission," if denied in equilibrium, amounts to exclusion. And Copps, like Adelstein, took the Antitrust Division to task for approving the merger unconditionally.[37] But Copps did not limit his statement to the exclusion frame, nor did his reasoning rest upon the access provider's incentive to impair a particular content provider's competitive prospects.

Neither statement explained the need for a zero-price rule, rather than more limited regulation, or acknowledged the contrast between the two commissioners' views. These omissions are unfortunate, because the differences matter: the two theories have different economic effects, as explained in the next section, and are addressed to different degrees by existing law. Their conflation leads to confusion in assessing proposals for new regulation. For example, if Adelstein is right to focus upon exclusion, then why

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does not go far enough. *See, e.g.*, Susan P. Crawford, *The Internet and the Project of Communications Law*, 55 UCLA L. REV. 359, 403-04 (2007). For them, particular types of content should not be singled out for high-quality access, even if the access is provided for free. That outcome is a plausible reading of the AT&T merger condition, which prohibits not only the sale of premium access but, equally, its "provi[sion]."

34 *See In re* AT&T Inc. and BellSouth Corp. Application for Transfer of Control, 22 F.C.C.R. 5662, 5837 (2007) (Adelstein, Comm'r, concurring) (arguing that the network neutrality condition was implemented to "address incentives for anti-competitive discrimination").

35 *Id* at 5836.

36 *Id.* at 5831 (Copps, Comm'r, concurring). Commissioner Copps named as exemplars "[t]he next Drudge Report, Wikipedia, Craigslist, Instapundit, or Daily Kos." *Id.*

37 *Id.* at 5829.

is the existing antitrust prohibition of exclusion, discussed in Part II, not a sufficient policy response? Why not seek instead a provision more closely tailored to exclusion concerns, rather than insist upon a zero-price rule, which, as we shall see, prohibits much more than exclusion? On the other hand, if extraction concerns justify a zero-price rule, as Copps suggests, can we ignore exclusion (and Adelstein's arguments) altogether? After all, a persuasive argument that rests upon extraction makes exclusion arguments unnecessary.

B. *The Potential Costs of Access Control*

Skeptics suggest that network neutrality regulation is a solution in search of a problem.[38] The commissioners' statements indicate two distinct problems to which a zero-price rule might respond. Distinguishing them, and placing each on a more rigorous footing, is a necessary step toward evaluating each as a justification for a zero-price rule.

Both theories are premised upon the access provider's possession of significant market power. The access provider market is currently a duopoly. Consumers buy broadband access from AT&T or another telephone company, or else from a cable company such as Comcast.[39] Access provision has declining average costs, making it difficult for a second cable company or second local telephone company to enter. Switching costs are significant. In the future, wireless or other technology may provide a third source of provision, but for now, the access provider controls a bottleneck. Where there are multiple providers, moreover, the providers are not identical rivals. There is no guarantee that these alternatives (or others, such as wireless service) will coexist in long-term equipoise. A technology with clear superiority, if it emerges, might tip the market toward monopoly.[40]

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38 For example, Representative Bobby Rush. *See* Anne Broache, *Tech Manufacturers Rally Against Net Neutrality*, CNET NEWS.COM, Sept. 19, 2006, http://www.news.com/2100-1028_3-6117241.html.

39 The FCC reports that nearly half of U.S. zip codes are served by either one or two ADSL or cable modem providers. FCC, HIGH-SPEED SERVICES FOR INTERNET ACCESS: STATUS AS OF JUNE 30, 2007, at tbl.16 (2008), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-280906A1.pdf [hereinafter FCC DEPLOYMENT STUDY] (reporting one such provider in 24% of zip codes, and two such providers in 22% of zip codes). In addition, 10% of zip codes reported no DSL or cable modem providers. The fraction of consumers, as opposed to zip codes, served at most by a duopoly is higher, since a provider is counted for the entire zip code even if it serves only business customers and even if it serves only part of the territory (as usually will be the case for multiple cable companies, as their territories seldom overlap). *See* U.S. GEN. ACCOUNTING OFFICE, BROADBAND DEPLOYMENT IS EXTENSIVE THROUGHOUT THE UNITED STATES, BUT IT IS DIFFICULT TO ASSESS THE EXTENT OF DEPLOYMENT GAPS IN RURAL AREAS 16-17 (2006), *available at* http://www.gao.gov/new.items/d06426.pdf. Limiting consideration to DSL and cable modem is appropriate because these two technologies dominate the market. *See* FCC DEPLOYMENT STUDY, *supra*, at tbl.6. Mobile wireless has significant penetration (if included with DSL and cable modem provision, it would have a market share around 25% on a total-lines basis) but is not currently a close substitute for many users.

40 I thank Mark Lemley for pointing this out to me.

1. Exclusion and Reduced Competition

An access provider with market power has, under certain circumstances, the incentive and ability to impair the competitive prospects of a content provider, in order to favor rival content in which the access provider has an economic interest.[41] The reduced competition in content leads to higher content prices for consumers and allocative inefficiency when consumer purchases are deflected to less desirable substitutes, as well as a productive inefficiency when lower-cost content is kept from the market.[42] The access provider profits from the reduced content competition either by owning the favored content or through a contractual relationship in which the content provider pays the access provider to exclude the rival content.

Under certain conditions, the access provider has no incentive to exclude in this way.[43] It is a familiar result from platform economics that one impetus to exclude is missing when the application can be used only in conjunction with the platform—a video game that works only with a particular console, for example. The platform can then earn maximum profit from "captive" application users without taking over the application's business.

Internet content, however, has many nonplatform users, judged from the perspective of a particular access provider. The audience for iFilm's video service is not limited to AT&T broadband customers. As a result, if AT&T can induce iFilm's exit (or deter its entry in the first place), AT&T might monopolize the content market through a corporate affiliate or contracting partner, and earn profit not only from captive AT&T customers but also from noncaptive users of the content.[44] For this strategy to work, the content

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41 These practices are termed "vertical" because the contracting parties are at different stages in the chain of production or distribution, but the same arguments apply whenever the parties produce complements. For excellent modern accounts, see MICHAEL D. WHINSTON, LECTURES ON ANTITRUST ECONOMICS 133-97 (2006); Patrick Rey & Jean Tirole, *A Primer on Foreclosure*, *in* 3 HANDBOOK OF INDUSTRIAL ORGANIZATION 2145 (Mark Armstrong & Rob Porter eds., 2007); Michael Riordan, *Competitive Effects of Vertical Integration*, *in* HANDBOOK OF ANTITRUST ECONOMICS (Paolo Buccirossi ed., forthcoming Apr. 2008).

42 If the platform owner is unable to make a binding contractual commitment to a single firm—because cheating is unobservable, perhaps, or the necessary contracts violate antitrust law—the platform may implement its commitment through vertical integration. If the vertical integration is inefficient, then exclusion entails a further social cost. *See* Oliver Hart & Jean Tirole, *Vertical Integration and Market Foreclosure*, BROOKINGS PAPERS ON ECONOMIC ACTIVITY: MICROECONOMICS 205, 207-10 (1990); Rey & Tirole, *supra* note 41, at 2158-62.

43 *See* RICHARD A. POSNER, ANTITRUST LAW 223-29 (2d ed. 2001); Aaron Director & Edward H. Levi, *Law and the Future: Trade Regulation*, 51 NW. U. L. REV. 281, 290-93 (1956); Joseph Farrell & Philip J. Weiser, *Modularity, Vertical Integration, and Open Access Policies: Towards a Convergence of Antitrust and Regulation in the Internet Age*, 17 HARV. J.L. & TECH. 85, 100-19 (2003).

44 An early articulation is Michael D. Whinston, *Tying, Foreclosure, and Exclusion*, 80 AM. ECON. REV. 837 (1990). For a nontechnical treatment, see Dennis W. Carlton, *A General Analysis of Exclusionary Conduct and Refusal to Deal: Why* Aspen *and* Kodak *Are Misguided*, 68 ANTITRUST L.J. 659, 667-68 (2001). This is the classic "desert island" story, which Carlton attributes to Robert Gertner. Daniel Rubinfeld and Hal Singer applied this theory to the merger between Time Warner and America Online. *See* Daniel L. Rubinfeld & Hal J. Singer, *Open Access to Broadband Networks: A Case Study of*

provider must face economies of scale, such as a fixed entry cost or demand-side network effects wherein one consumer's valuation of the content increases with the number of other users. Internet content provision often satisfies that assumption. The access provider must also be capable of disrupting, by means of exclusion, the content provider's ability to exploit scale. Whether access providers can deprive a content provider of scale is considered in Part II.

Commissioner Adelstein is far from alone in relying upon exclusion concerns to justify a zero-price rule. Google, for example, supports the rule to prevent "those last-mile activities that would discriminate against certain Internet applications or content with an anticompetitive intent."[45] Scholars have hypothesized a negative effect on competition and explored at length the different mechanisms by which exclusion might occur.[46] Legislative proposals that implement network neutrality have invoked the exclusion frame.[47] When network neutrality proponents describe the historical antecedents of current policy proposals—for example, the famous exclusive contract between Western Union and the Associated Press—the examples reflect exclusion concerns.[48] Network neutrality opponents understand proponents to be arguing that regulation is needed in order to address exclusion,[49] prompting the response that exclusion is unlikely[50] and best remedied by existing antitrust

the AOL/Time Warner Merger, 16 BERKELEY TECH. L.J. 631 (2001) [hereinafter Rubinfeld & Singer, *Open Access*]; Daniel L. Rubinfeld & Hal J. Singer, *Vertical Foreclosure in Broadband Access?*, 49 J. INDUS. ECON. 299 (2001) [hereinafter Rubinfeld & Singer, *Vertical Foreclosure*].

45 Google Public Policy Blog, *supra* note 29.

46 *See, e.g.*, Barbara van Schewick, *Towards an Economic Framework for Network Neutrality Regulation*, 5 J. ON TELECOMM. & HIGH TECH. L. 329, 333 (2007) (arguing that the object of network neutrality is "to design rules that prevent network operators and ISPs from using their power over the transmission technology to negatively affect *competition* in complementary markets for applications, content and portals") (emphasis added).

47 For example, one bill favorably reported out of the House Judiciary Committee had as its announced purpose "to promote competition, to facilitate trade, and to ensure competitive and nondiscriminatory access to the Internet." Internet Freedom and Nondiscrimination Act of 2006, H.R. 5417, 109th Cong. § 2 (2006) (statement of purpose). The accompanying report explained that the bill was designed to "preserv[e] an antitrust remedy for anticompetitive and discriminatory practices" by access providers. H.R. REP. NO. 109-541, at 2 (2006); *see also id.* at 4 (emphasizing the similarity between this bill and earlier antitrust interventions in the telecommunications industry, particularly the breakup of the Bell System).

48 *See, e.g.*, Tim Wu, *Why Have a Telecommunications Law? Anti-Discrimination Norms in Communications*, 5 J. ON TELECOMM. & HIGH TECH. L. 15, 28-35 (2006) (reviewing Western Union's exclusive contract with the Associated Press, the Kingsbury Commitment, and Carterfone).

49 *E.g.*, Owen, *supra* note 18, at 5; Bruce Owen & Gregory Rosston, *Local Broadband Access: Primum Non Nocere or Primum Processi? A Property Rights Approach*, *in* NET NEUTRALITY OR NET NEUTERING: SHOULD BROADBAND INTERNET SERVICES BE REGULATED? 163, 176 (Thomas M. Lenard & Randolph J. May eds., 2006) ("The *commercial* demand for access regulation arises from a fear . . . that [access providers] will themselves integrate vertically into various content, aggregation, or equipment businesses, and that this will be harmful to independent suppliers."); Yoo, *supra* note 33; *see also* Shelanski, *supra* note 7, at 102 (characterizing network neutrality as a response to exclusion concerns).

50 *See, e.g.*, J. Gregory Sidak, *A Consumer-Welfare Approach to Network Neutrality Regulation of the Internet*, 2 J. COMPETITION L. & ECON. 349, 470-71 (2006).

law.[51] This focus is unsurprising, given the longstanding centrality of exclusion as a concern of telecommunications policy,[52] and the focus upon exclusion in examining the merger of Time Warner and America Online, a notable precursor to the network neutrality debate.[53]

2. Extraction and Reduced Innovation

Even without equilibrium exclusion, an access provider can profit by extracting profits from the content provider.[54] The access provider does not bother getting into the content business because it can capture the surplus produced by the content provider by virtue of its status as a bottleneck. For example, AT&T might insist that YouTube and iFilm each pay AT&T part of the content provider's profits in exchange for providing high-quality video transmission. Such access charges are a common practice in some industries. Video game console makers, for example, receive royalties from independent game developers. Credit card payment systems such as Mastercard and Visa charge merchants a transaction fee for use of the network. An extraction incentive is present even if the access provider has an affiliated, competing content provider, since each customer who uses the competing affiliated content, rather than the independent content, represents a foregone access charge.[55]

Extraction entails a threat of exclusion, but the threat is not carried out in equilibrium; the threat is therefore not exclusionary conduct in the usual sense. The profitability of an extraction strategy, as implemented by an access provider or other platform, is premised upon a thriving set of independent applications. The activity is private taxation to raise revenue, rather than to deter. Exclusion relies upon disfavoring one content provider relative to another—the raising of a rival's costs.[56] Concerns about extraction apply, by contrast, even if all content providers are affected equally and none is favored—where it is a complementor, rather than a rival, whose costs are being raised.

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51 Hahn & Litan, *supra* note 30, at 10-12.

52 *See, e.g.*, JONATHAN E. NUECHTERLEIN & PHILIP J. WEISER, DIGITAL CROSSROADS: AMERICAN TELECOMMUNICATIONS POLICY IN THE INTERNET AGE 16-22 (2004).

53 *See* Rubinfeld & Singer, *Open Access*, *supra* note 44; Rubinfeld & Singer, *Vertical Foreclosure*, *supra* note 44.

54 Extraction is consistent with the "one monopoly profit" no-exclusion result—indeed, it is presumed in that account. *See* Jean Tirole, *The Analysis of Tying Cases: A Primer*, COMPETITION POL'Y INT'L, Spring 2005, at 1; Whinston, *supra* note 44, pt. 3; *see also* Joseph Farrell & Michael L. Katz, *Innovation, Rent Extraction, and Integration in Systems Markets*, 48 J. INDUS. ECON. 413 (2000); Farrell & Weiser, *supra* note 43, at 104 (explaining that side payments are consistent with the "internalizing complementary efficiencies" baseline).

55 Tirole, *supra* note 54, at 6.

56 *See* Steven C. Salop & David T. Scheffman, *Raising Rivals' Costs*, 73 AM. ECON. REV. 267 (1983).

Extraction is facilitated by effective price discrimination. That is, purchasers with relatively high willingness to pay and few effective substitutes for access provision are charged a higher price. Familiar examples include unrestricted airline fares and hardcover books. As discussed above, common carriers frequently implement price discrimination. Price discrimination increases the carrier's profits, thus providing an additional means to cover fixed costs. Price discrimination can also help to tune allocation and production decisions to better correspond to demand variations among consumers.[57]

On the simplest account, extraction simply shifts resources from the content provider to the access provider. Google and other content providers, of course, have reason to support a zero-price rule even if extraction raises merely a distributional issue without any consequence for efficiency. In addition, extraction has a dynamic efficiency consequence if it alters the investment decisions of content providers.[58] As a theoretical matter, it may have no such consequence, given the access provider's incentive to increase surplus—which the access provider can then extract—by ensuring high-quality content.[59] If there is a dynamic efficiency effect, it entails a tradeoff: reduced incentives for entry and investment by content providers, combined with increased incentives to invest in access provider infrastructure, via the contribution to fixed costs just mentioned. As a theoretical matter, it is not apparent which effect is larger.

Access providers have not defended any right to anticompetitive exclusion, but extraction is an explicit goal. AT&T's CEO candidly explained that content providers "don't have any fiber out there. They don't have any wires. They don't have anything. They use my lines for free—and that's bull. For a Google or a Yahoo! or a Vonage or anybody to expect to use these pipes for free is nuts!"[60] As Verizon's deputy general counsel explained his company's point of view: "The network builders are spending a fortune constructing and maintaining the networks that Google intends to ride on with nothing but cheap servers. It is enjoying a free lunch that should, by any rational account, be the lunch of the facilities providers."[61]

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57 For a thoughtful introduction to these issues, see Jeffrey K. MacKie-Mason & Hal R. Varian, *Pricing the Internet*, *in* PUBLIC ACCESS TO THE INTERNET 269 (Brian Kahin & James Keller eds., 1995); Hal R. Varian, *Price Discrimination*, *in* 1 HANDBOOK OF INDUSTRIAL ORGANIZATION 597 (Richard Schmalensee & Robert Willig eds., 1989). Varian currently serves as chief economist at Google but has not joined Google's advocacy effort in favor of network neutrality regulation.

58 *See, e.g.*, Gawer & Henderson, *supra* note 5, at 5 (noting that platform incentives to squeeze complementors may undermine innovation incentives).

59 *See infra* Section III.D for further discussion.

60 Spencer E. Ante & Roger O. Crockett, *Rewired and Ready for Combat: SBC and Verizon Are Spending Billions to Stay Competitive in the Broadband Era*, BUS. WK., Nov. 7, 2005, at 110. *See also* Paul Taylor, *AT&T Chief Warns on Internet Costs*, FIN. TIMES, Jan. 31, 2006, at 22 ("I think the content providers should be paying for use of the network. . . . They shouldn't get on [the network] and expect a free ride." (quoting AT&T CEO Edward Whitacre)).

61 Arshad Mohammed, *Verizon Executive Calls for End to Google's "Free Lunch,"* WASH. POST, Feb. 7, 2006, at D1 (quoting Verizon deputy general counsel John Thorne). One spokesman put the issue this way: "Is the only potential payer going to be the end user, the customer, or are there other

Extraction concerns—in particular, that extraction will reduce the profitability of and hence investment in independent content development—motivate many calls for network neutrality regulation. We saw one example already, in Commissioner Copps's statement about the AT&T merger condition.[62] Some regulation proponents appear to focus upon extraction concerns and deemphasize anticompetitive exclusion.[63] The same argument, and the reference to a "toll," have been emphasized by academics[64] and interest groups.[65] As Google's Vint Cerf, an Internet pioneer, has argued, network neutrality regulation ensures that "people with interesting ideas . . . [do] not have to leap over any kind of a hurdle to buy access to customers."[66] One member of the Federal Trade Commission has framed the network neutrality issue explicitly in extraction terms.[67]

3. Additional Harms

The two previous sections present a simple dichotomy. Exclusion is bad because it undermines competition. Extraction is troubling if it undermines innovation. This dichotomy, however, does not exhaust the harms of each

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ways to finance infrastructure by asking content providers to pay as well?" Tom Abate, *Speed Bumps on the Information Highway*, S.F. CHRON., June 18, 2006, at A1 (quoting Daniel Brenner, senior vice president for law and regulatory policy for the National Cable and Telecommunications Association).

62 *See supra* note 36 and accompanying text.

63 *See, e.g.*, *Network Neutrality: Hearing Before the S. Comm. on Commerce, Sci. and Transp.*, 109th Cong. 9 (2006) [hereinafter Lessig Testimony] (statement of Lawrence Lessig), *available at* http://commerce.senate.gov/pdf/lessig-020706.pdf (disclaiming reliance upon antitrust arguments); Brett M. Frischmann & Barbara van Schewick, *Network Neutrality and the Economics of an Information Superhighway: A Reply to Professor Yoo*, 47 JURIMETRICS J. 383, 414 n.119 (2007) (explaining that network neutrality "goes beyond" antitrust reasoning by preserving high profits, and hence incentives, for independent content providers).

64 *See, e.g.*, Lawrence Lessig, *Congress Must Keep Broadband Competition Alive*, FIN. TIMES, Oct. 19, 2006, at 17 [hereinafter Lessig, *Congress*] (identifying "internet toll booths" that "impos[e] a special tax"); Lawrence Lessig, *I Blew It on Microsoft*, WIRED, Jan. 2007, at 96 [hereinafter Lessig, *I Blew It*] ("Every dominant commercial competitor has the same incentive: to build a business that extracts all potential value from the pipes that company owns."); Lawrence Lessig & Robert W. McChesney, *No Tolls on the Internet*, WASH. POST, June 8, 2006, at A23; *see also Network Neutrality: Competition, Innovation, and Nondiscriminatory Access: Hearing Before the Telecom and Antitrust Task Force of the H. Comm. on the Judiciary*, 109th Cong. 4 (2006) [hereinafter Wu Testimony] (statement of Tim Wu) (recognizing that nonneutrality amounts to a tax but likening its imposition to an illegal protection racket); *id.* at 7 (describing the problem as "nothing more than a tax").

65 American Civil Liberties Union, ACLU & Youth: Why We Need Net Neutrality Protections, http://www.aclu.org/freespeech/internet/27159res20061023.html (last visited Apr. 18, 2008) (offering "Expensive Downloads and [Podcasting]" as one of several reasons and noting that absent net neutrality, "network providers could charge you more to download . . . videos or music, or to use services such as Rhapsody, YouTube, Napster, and iTunes . . . [and] tell you which download service you have to use, charging you a toll if you decide to use one of their competitors").

66 Abate, *supra* note 61, at A1.

67 *See* Jon Leibowitz, Comm'r, FTC, Concurring Statement Regarding Staff Report: Broadband Connectivity Competition Policy 2-3 (June 27, 2007), *available at* http://www.ftc.gov/speeches/leibowitz/V070000statement.pdf (arguing that "expropriat[ion]" by access providers will harm long-run incentive to develop products).

strategy. Exclusion, aside from its static consequences for competition, can undermine innovation in content. The anticipation of exclusion may discourage prospective entrants from developing new content. This consequence of exclusion, however, lacks a distinctive policy implication. If exclusion imposes a substantial static harm, then exclusion should be prohibited even if there is no dynamic inefficiency. Moreover, if the dynamic harms of extraction provide a strong general basis for zero-price regulation, it adds little to show that exclusion, when and if it occurs, also has a negative dynamic effect.

Extraction strategies can have static effects, aside from the dynamic effect on application innovation. Price discrimination, which is central to the operation of extraction, is typically executed imperfectly. A seller's information and contracting technologies are ordinarily not fine-grained enough to perfectly target the buyer's surplus. An application provider will engage in costly avoidance strategies and may pass along part of its increased expense to its consumers, perhaps in an inefficient fashion.[68] In addition, the platform will expend real resources in order to improve its technology of price discrimination, including inefficient decisions about "vertical integration," the ownership of complementary businesses. These costs are difficult to evaluate and measure, which is one reason why the static inefficiency of imperfect extraction has not been a major focus of competition policy or a prominent argument for network neutrality proponents.

These effects complicate but do not erase the basic dichotomy. Exclusion raises distinctive concerns about static welfare losses, to which antitrust policy is primarily directed. Extraction raises concerns about dynamic welfare losses, particularly with respect to independent application development, and this is a preoccupation of innovation policy.

C. *The Consequences of Conflation*

Exclusion and extraction concerns raise different questions about the advisability of a zero-price rule. For extraction, three issues are most important. First, a zero-price rule might cause the access provider to effect extraction by other, less direct means. Second, a zero-price rule, to the extent it alters investment incentives, might not do so in a socially desirable fashion. Third, the access provider can "contract into" effective incentives for content development, despite its legal entitlement to extract. These questions are considered in Part III.

For exclusion, two issues arise. The first is superfluity: existing antitrust law prohibits some forms of exclusion. Provided that antitrust law as currently enforced successfully identifies and remedies exclusion, there is no need for

68 Joseph Farrell, Presentation at FTC Broadband Connectivity Competition Policy Workshop 155 (Feb. 13, 2007) (transcript available at http://www.ftc.gov/opp/workshops/broadband/transcript_070213.pdf) (describing this problem).

additional regulatory intervention. The second is overinclusion. Even if new regulation is necessary to prevent exclusion, it need not take the form of a zero-price rule. A zero-price rule not only prevents an access provider from impairing a content provider's competitive prospects relative to a rival, but also prevents the charging of *any* access fee. That is, the rule prohibits both exclusion *and* extraction, a result that is difficult to justify unless extraction concerns are important.

Unfortunately, policy and academic discussions occur at a level of generality that subsumes exclusion and extraction arguments. Condemnations of access provider "discrimination" do not carefully distinguish practices that set different prices for different content types—a garden-variety extraction strategy of price discrimination[69]—from practices that disfavor one content provider relative to its rival. Phrases that identify the desired end state, such as "innovation without permission,"[70] neither rule in nor rule out the imposition of a uniform, zero price. In this respect, at least, the network neutrality debate presents nothing new, for similar confusion permeates analyses of common carriage as well.[71]

The resulting confusion has several bad consequences. Regulatory proponents justify a zero-price rule as a response to anticompetitive exclusion, without recognizing or justifying the rule's overinclusiveness relative to the exclusion concern. One of the more extreme consequences has been proposed legislation that would enshrine a zero-price rule as a substantive antitrust rule backed by private enforcement and treble damages.[72] Meanwhile, skeptics aim their critiques at anticompetitive exclusion, thereby giving the extraction arguments short shrift.

II. Reconsidering Exclusion

This Part examines whether concerns about exclusion of content providers justify a zero-price rule. As a general matter, new regulation faces three formidable hurdles. First, there must be a plausible social harm to remedy. Second, existing law—here, antitrust law—must be an ineffective means of identifying and remedying the harm; otherwise, additional regulation is superfluous. Third, the regulation must effectively prevent the harmful conduct without also prohibiting too much harmless or desirable conduct, and without creating large new costs.

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69 *See* Atkinson & Weiser, *supra* note 7, at 50-51.

70 Letter from Jeff Bezos, CEO, Amazon.com, et al., to Senators Ted Stevens & Daniel Inouye (Apr. 26, 2005), *available at* http://netcompetition.org/docs/pronetneut/leaders_042506.pdf.

71 As Bonbright explained in 1961, "Readers of the treatises and the case law on public utility and railroad rates will often come across bald statements to the effect that . . . rate discrimination is unlawful. . . . [S]uch statements are grossly inaccurate. What the law forbids is merely 'undue' or 'unjust' discrimination." BONBRIGHT, *supra* note 19, at 370.

72 *See* H.R. 5417, 109th Cong. § 3 (2006) (adding a new section 28 to the Clayton Act).

Section II.A considers the most famous modern example of anticompetitive exclusion, the U.S. government's antitrust case against Microsoft, as a source of analogies to the network neutrality context, in order to identify gaps in the existing prohibitions of antitrust that a zero-price rule might remedy. Sections II.B and II.C consider two possible gaps in antitrust coverage—call them the Vonage and Wikipedia gaps. The Vonage gap arises when an access provider, which already owns a legacy content business such as ordinary telephone service, excludes a competing content business. The Wikipedia gap arises when socially produced content competes with market production. Section II.B discusses why the Vonage gap does not justify zero-price regulation. The Wikipedia gap presents a stronger argument for regulation, but, as explained in Section II.C, implementation of such regulation presents substantial practical difficulties.

A. *Identifying Gaps in Antitrust Law*

United States v. Microsoft offers a useful template to frame the incentives of access providers and content providers.[73] In that case, the government alleged that Microsoft used its Windows operating system monopoly to impair the competitive prospects of Netscape's browser, in order to prevent the emergence of Netscape as a competing software platform.[74] In order to exploit the analogy—which is inexact, to be sure[75]—we must first ask, who is Microsoft here? Is it the access provider or the content provider?

Consider, first, the access provider. An access provider could adopt a Microsoft strategy and preserve profits by forestalling competition in access provision. This scenario is a departure from the examples considered above. For example, AT&T could secure an agreement with YouTube, providing that AT&T customers receive exclusive access to YouTube content, thus shutting

73 253 F.3d 34 (D.C. Cir. 2001) (en banc) (per curiam); *cf.* Lessig, *I Blew It*, *supra* note 64, at 96 (assessing the "Microsoft-like network-neutrality debate").

74 *See* 253 F.3d at 54-56 (discussing applications barrier to entry). For a technical account, see Dennis W. Carlton & Michael Waldman, *The Strategic Use of Tying to Preserve and Create Market Power in Evolving Industries*, 33 RAND J. ECON. 194 (2002); for a nontechnical explanation, see Carlton, *supra* note 44. This theory of exclusion is distinct from the one discussed in Part I, in which the platform excludes in order to harvest incremental profits from noncaptive application customers. This discussion focuses upon the conduct examined in the D.C. Circuit's landmark 2001 decision. It omits discussion of the earlier per-processor license case, enforcement of the earlier consent decree, and later allegations involving the Media Player, server software, and desktop search integration into Windows Vista.

75 The particular mechanism considered in *Microsoft*, in which a complement today threatened to become a substitute in the future, is not directly applicable. But it may not be entirely irrelevant, if independent content providers threaten entry into the access provision business, as suggested by Google's recent interest in municipal Wi-Fi and 700-megahertz spectrum auctions. *See* Elinor Mills, *Google Versus the Telecoms*, CNET NEWS.COM, Nov. 30, 2007, http://www.news.com/Google-versus-the-telecoms/2100-1039_3-6220909.html (describing Google proposal, later abandoned, to offer municipal Wi-Fi in San Francisco, and plan to bid, ultimately unsuccessfully, in an FCC spectrum auction held in March 2008).

out non-AT&T customers within AT&T's territory. The point would be to slow the entry or induce the exit of competing access providers, by depriving them of content valued by broadband consumers.[76] Zero-price regulation—which aims to prevent differential treatment of content providers by an access provider, not differential treatment of access providers by a content provider—does not address this problem at all.

Network neutrality discussions are not concerned with the Microsoft-like incentives of access providers, but rather with the Microsoft-like incentives of *content providers*. The worry is that a content provider, linked by contract or common ownership to an access provider, will compensate the access provider in exchange for the latter's exclusion of a competing content provider.

Focusing upon content provider incentives may seem an unfamiliar way to think about the problem, given the demonization of access providers that sometimes accompanies policy analyses of broadband regulation. The slippage occurs because in the most familiar scenarios of concern, the content business that benefits from exclusion is owned in common with the access business that does the excluding. For example, Time Warner produces content, such as CNN.com, in addition to providing broadband access. AT&T, in addition to its Internet access business, provides ordinary telephone service—a content business, properly understood. The incentive of YouTube with respect to iFilm is analogous to CNN.com's incentive with respect to other news providers. So is AT&T's incentive to preserve its legacy business from encroachment by Vonage and other companies deploying voice-over-Internet protocol (VoIP), which enables users to hold voice conversations by transmitting the information as packets, without paying for ordinary telephone service.

Despite the economic similarity, there is a crucial doctrinal difference between exclusion that occurs through contract, as in a hypothetical YouTube-AT&T agreement to exclude iFilm, and exclusion accomplished through a refusal to deal—for example, a refusal by AT&T to permit Vonage to reach AT&T customers. Here we see a second use for the *Microsoft* analogy, besides the identification of troubling conduct, which is to identify the reach of existing antitrust prohibitions. Conduct that closely resembles the activity condemned in *Microsoft* is already subject to antitrust prohibition, and hence a poor candidate for new regulation. For exclusion accomplished by contract, such as the hypothetical YouTube-AT&T agreement to exclude iFilm, a zero-price rule is

76 Put another way, a new entrant would be forced to secure an offering comparable to YouTube before entering and must now enter at both the platform and application layers. For a theoretical treatment of two-level entry, see Jay Pil Choi & Christodoulos Stefanadis, *Tying, Investment, and the Dynamic Leverage Theory*, 32 RAND J. ECON. 52 (2001); see also Rubinfeld & Singer, *Open Access*, *supra* note 44, at 657-61, which found anticompetitive exclusion of rival access providers to be an unlikely effect of the Time Warner-AOL merger. Some access providers do pay for premium content such as ESPN360, a web-based streaming video service that is apparently not offered exclusively. *See* Adam Thompson, *ESPN Calls a Do-Over on Its Online-Video Site*, WALL ST. J., Aug. 8, 2007, at B1 (reporting that Verizon and AT&T have signed up for the service, while cable companies have declined).

unnecessary. As the *Microsoft* case demonstrates, the substantive reach of antitrust law already extends to contracts that choke off the distribution options of a rival.[77]

The *Microsoft* comparison has a third payoff, which is to raise questions about the effectiveness of after-the-fact antitrust suits as a deterrent and remedy. Antitrust cases can take years to resolve, and in the meantime, an incumbent's control of the status quo can become entrenched. *Microsoft* is, perhaps, an apt example. Other cases, however, are less controversial demonstrations of the effectiveness of antitrust in coping with exclusion accomplished by contract.[78]

When an access provider acts in the interest of its content affiliate, as opposed to a contracting partner, the antitrust treatment is more complex. That circumstance is considered next.

B. *The Vonage Gap: Refusing to Deal with a Legacy Business Competitor*

Exclusion accomplished through a refusal to deal raises distinct issues. Although functionally similar to exclusion achieved pursuant to a contract, its legal treatment is different. The exclusion by refusal to deal is not covered by section 1 of the Sherman Act, which requires an agreement.[79] That leaves section 2, which prohibits monopolization.[80] But refusals to deal often fall outside the scope of section 2, a lesson reinforced by a recent, controversial Supreme Court ruling.[81]

There is less to this apparent gap, however, than meets the eye. Fragmentation in the access provider market makes some refusals ineffective.

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77 Such cases can proceed under either section 1 or section 2 of the Sherman Act. *See, e.g.*, United States v. Visa, 344 F.3d 229 (2d Cir. 2003) (condemning, as violation of section 1, exclusionary agreements that prevented participating banks from issuing the credit cards of competing networks); *Microsoft*, 253 F.3d at 58-64 (condemning, as violation of section 2, contracts that prevented personal computer makers from distributing competing Netscape browser); *see also* United States v. Dentsply, 399 F.3d 181, 193 (3d Cir. 2005) (condemning, as violation of section 2, a sales condition imposed by a manufacturer that prevented buyers from purchasing products sold by competing manufacturers; condition was "as effective as those in written contracts"); *cf.* Lorain Journal Co. v. United States, 342 U.S. 143 (1951) (condemning, as violation of section 2, a refusal to sell advertising space except on the condition that the customer not buy from a rival). For academic analyses, see Hahn & Litan, *supra* note 30, at 10 (arguing that antitrust is sufficient to deal with "discriminat[ion] among unaffiliated content providers"); Robert W. Hahn & Scott Wallsten, *The Economics of Net Neutrality*, ECONOMISTS' VOICE, June 2006, at 2, *available at* http://www.bepress.com/ev/vol3/iss6/art8 (similar).

78 For example, the *Visa* and *Dentsply* cases discussed *supra* at note 77. Moreover, ex ante regulation is hardly quick and painless in practice. A regulatory proceeding can also take years to reach a conclusion, and can itself entrench a nonoptimal industry arrangement. A thorough review of the debate over ex post and ex ante modes of regulation is beyond the scope of this Article. See *supra* note 7 for an introduction to the relevant literature.

79 *See* 15 U.S.C. § 1 (2000). In this respect, the Vonage example resembles *Theatre Enterprises, Inc. v. Paramount Film Distrib. Corp.*, 346 U.S. 537 (1954), in which each firm had an independent reason not to do business with the plaintiff, whatever choice its rivals made.

80 *See* 15 U.S.C. § 2 (2000).

81 Verizon Commc'ns Inc. v. Law Offices of Curtis V. Trinko, LLP, 540 U.S. 398 (2004).

Moreover, where refusals do pose an anticompetitive threat, existing antitrust law may address that conduct—and even if not, a broad zero-price rule is an inappropriate means to address the conduct.

1. Fragmentation of Access Provision

Subsection I.B.1 introduced one theory of anticompetitive exclusion: that an access provider might monopolize a content market, in order to earn profit not only from its captive customers, but also noncaptive users of the content. A key condition for the success of that strategy is the access provider's ability through exclusion to undermine the content provider's achievement of effective scale—for example, by stealing so many customers that the application is unable to cover a large fixed cost or achieve sizable network effects among users.

That ability depends upon the importance of the access provider's captive customers to the success of the content provider. Even if a particular access provider has market power vis-à-vis its own consumers, it may be a quite unimportant source of customers for a content provider. The noncaptive customers—customers whose access is not controlled by the access provider—protect the content provider against exclusion by preserving the content provider's scale.[82] The presence of such customers—the very prize that motivates exclusion, from an access provider's perspective—also makes exclusion more difficult to achieve.

Most content markets have a large number of noncaptive customers. That is true, even if the market for content is limited to U.S. broadband customers, since the largest U.S. access provider controls no more than a quarter of that market.[83] For some content, dial-up service is sufficient, providing a content provider with an additional source of noncaptive customers, and hence scale. And some content reaches a global audience, in which case the threat to scale recedes further.

Some content providers enjoy a further advantage that reduces the exclusion threat. If the content is complementary to other content provided by the same firm—for example, Google's integrated search, e-mail, and office productivity offerings—the content provider will be less vulnerable to attempts by an access provider to induce its exit. As a general matter, then, a content

82 *See* Robert E. Litan & Hal J. Singer, *Unintended Consequences of Net Neutrality Regulation*, 5 J. ON TELECOMM. & HIGH TECH. L. 533, 555-58 (2007) (making a similar point).

83 As of the end of 2007, cable had 33.5 million broadband subscribers, of which the main providers are Comcast (13.2 million), Time Warner (7.6 million), Cox (3.7 million), Charter (2.7 million), and Cablevision (2.3 million). DSL had 28.5 million subscribers, of which the main providers are AT&T (14.2 million), Verizon (8.2), Qwest (2.6 million), and Embarq (1.3 million). *See* Press Release, Leichtman Research Group, Over 8.5 Million Added Broadband from Top Cable and Telephone Companies in 2007 (Mar. 3, 2008), *available at* http://www.leichtmanresearch.com/press/030308release.html. On these figures, Comcast has a 21% share of U.S. broadband.

provider is not very vulnerable to exclusion by an access provider that controls only a small part of the content provider's audience. That strategy can no more succeed than if a single computer manufacturer, such as Dell, had tried to shut down Netscape by refusing to carry the Netscape browser.

There is a second mechanism of exclusion by refusal to deal, however, to which the fragmentation critique does not apply. To see why, let us return to the "AT&T versus Vonage" example. As already mentioned, AT&T offers both broadband access and ordinary telephone service, a legacy content business that competes with independent VoIP providers such as Vonage.[84] Allowing Vonage to reach AT&T customers erodes the profitability of the legacy business unless AT&T can implement an access charge that maintains existing profitability.[85] Otherwise, the access provider's dominant strategy is exclusion.

Moreover, each access provider with a legacy business has the same incentive. Even if one access provider is too small to have much effect on application scale, the access providers' identical decisions, considered collectively, may have an exit-inducing effect. This is so, even if no access provider has any prospect of earning profits from noncaptive customers. The resulting exclusion—with accompanying static and dynamic harms—presents a significant problem for existing antitrust law, or else new regulation, to consider.

2. Existing Antitrust Prohibitions

It is a difficult question whether an access provider's refusal to deal with a VoIP provider triggers antitrust liability. Refusals to deal have long been controversial as a source of the anticompetitive action requirement of section 2,[86] even beyond the skepticism with which the judiciary views exclusion claims generally.[87] The reluctance to impose liability has two bases. The first is that a refusal has welfare-increasing elements. For example, the prospect of profits from above-cost pricing is an inducement to innovative activity that

84 Major providers of broadband access also have VoIP businesses. *See, e.g*, Press Release, Comcast Corp., Comcast Reports 2007 Results and Outlook for 2008, at 3 (Feb. 14, 2008), *available at* http://biz.yahoo.com/prnews/080214/neth001.html (reporting 2.5 million "Comcast Digital Voice" subscribers, producing $1.8 billion in revenue, offset by declining revenues from circuit-switched telephony).

85 In theory, AT&T could set an access fee equal to the profit lost from each customer that defects to Vonage, thereby causing Vonage to internalize the effect of its entry, and aligning the interests of the two firms.

86 *See, e.g.*, United States v. Aluminum Co. of America, 148 F.2d 416 (2d Cir. 1945). One possible response is to attempt to impose liability only in a well-defined set of cases. For such a proposal, see Glen O. Robinson, *On Refusing To Deal with Rivals*, 87 CORNELL L. REV. 1177 (2002).

87 *See, e.g.*, Schor v. Abbott Labs., 457 F.3d 608 (7th Cir. 2006) (Easterbrook, J.).

mandated access undercuts.[88] Refusal also preserves vertical integration, which internalizes demand externalities across complementary markets, thereby avoiding the so-called "double marginalization" problem.[89] Refusal also avoids duplicative investments by content providers, a particularly relevant factor where the content provider offers a "me-too" product rather than an innovative improvement.[90]

The second basis is a set of prudential concerns about the ability of a court to identify and accomplish procompetitive interventions in the marketplace. For example, it is difficult for an outside observer to discern what is going on, compared to contracted-for exclusion, when the relevant basis for comparison, the bottleneck's treatment of a corporate affiliate, is hidden from view within the firm. It is also difficult to identify natural limits upon the scope of liability, since almost any source of competitive advantage can be characterized as the bottleneck portion of an integrated firm and hence a candidate for court-mandated access. And it is difficult to identify the "right" regulated price, a question outside the competence of a generalist court.[91]

Beyond these policy bases for denying liability, a recent Supreme Court case, *Verizon Communications Inc. v. Law Offices of Curtis V. Trinko, LLP*,[92] might seem to rule out liability entirely. There, plaintiff alleged that an incumbent local exchange carrier had refused to deal with a rival carrier, in violation of the carrier's interconnection obligation under the Telecommunications Act of 1996. One reading of that case, by no means the narrowest, is that refusals to deal by telecommunications providers are now beyond antitrust scrutiny.[93]

Despite these difficulties, a solid argument can be made that an access provider's refusal to deal with a VoIP provider does trigger antitrust liability by emphasizing the refusal's negative effect on competition (and, less convincingly, innovation[94]). Suppose, in what follows, that the welfare loss

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88 Verizon Commc'ns Inc. v. Law Offices of Curtis V. Trinko, LLP, 540 U.S. 398, 407 (2004). This is the mainstream view. *See, e.g.*, FTC STAFF REPORT, *supra* note 4, at 120 (quoting *Trinko* on this point with approval).

89 When multiple firms in complementary markets exercise market power independently, the aggregate distortion increases. For an early discussion of the point, see AUGUSTIN A. COURNOT, RESEARCHES INTO THE MATHEMATICAL PRINCIPLES OF THE THEORY OF WEALTH 103 (Nathaniel T. Bacon trans., MacMillan 1927) (1838).

90 *See* N. Gregory Mankiw & Michael D. Whinston, *Free Entry and Social Inefficiency*, 17 RAND J. ECON. 48 (1986) (demonstrating that free entry can be inefficient if entrants merely steal business from rivals); Patrick DeGraba, *Why Lever into a Zero-Profit Industry: Tying, Foreclosure, and Exclusion*, 5 J. ECON. & MGMT. STRATEGY 433 (1996) (specifying conditions under which exclusion increases welfare by reducing wasteful duplication of fixed costs by independent producers).

91 *See, e.g.*, Phillip Areeda, *Essential Facilities: An Epithet in Need of Limiting Principles*, 58 ANTITRUST L.J. 841, 841 (1990).

92 540 U.S. 398 (2004).

93 A narrower reading, considered *infra*, limits the holding to situations where any competitive harm is already identified and remedied by the sector-specific regulatory regime.

94 The incumbents' own use of VoIP suggests that VoIP innovation might not depend upon granting access to independent VoIP providers.

from reduced competition is larger than the welfare-increasing aspects of refusal—for if not, the basic premise for government intervention (whether by antitrust or new regulation) is lacking. In any event, the argument that a refusal has a welfare-increasing effect does not distinguish this conduct from an exclusionary contract, which (if permitted) also increases ex ante incentives,[95] though the similar economic effects of exclusionary refusals and exclusionary contracts has been underappreciated by courts.

The remaining objections to antitrust liability can be overcome. *Trinko* does not stand in the way. *Trinko* and other cases have denied liability when the resource withheld by an incumbent is not generally available for sale: new product plans, as in *Berkey Photo*,[96] or "unbundled network elements" not generally sold to consumers, as in *Trinko*. A VoIP provider such as Vonage, by contrast, seeks to take advantage of a facility that is made broadly available by the access provider.[97] This distinction places a manageable limit on the scope of liability. Moreover, *Trinko* emphasized that effective sectoral regulation that addresses the conduct reduces the incremental value of antitrust intervention.[98] Similarly effective regulation addressed to the conduct is absent here. In sum, *Trinko* does not bar antitrust liability for an access provider's refusal to deal with Vonage.[99]

If these arguments convince a court, then there is no role here for additional regulation. If not, and if (under our assumptions) there is a Vonage gap to fill, a zero-price rule is the wrong way to fill it. A zero-price rule is radically overinclusive relative to the Vonage gap. It prohibits not only parallel refusals to deal that are (possibly) outside the scope of antitrust, but also refusals that are unlikely to raise any competitive concern, exclusive contracts already prohibited by antitrust law, and extraction strategies that have nothing to do with competition.

Such overinclusion might conceivably be tolerated if no narrower rule were feasible. But in fact, a narrower rule is readily available. Restricting the rule's application to cases when the content provider seeks access from an access provider that owns a competing legacy business would focus the rule's scope. Prohibiting only discriminatory treatment for independent content, relative to affiliates, would likewise narrow the rule as to substance. To be sure, the narrower rule entails administrative complexity, in determining whether discriminatory treatment has occurred. But in this respect the seeming

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95 *Cf.* Einer Elhauge, *Defining Better Monopolization Standards*, 56 STAN. L. REV. 253, 301-05 (2003) (noting pervasiveness of tradeoff between innovation and competition).

96 Berkey Photo, Inc. v. Eastman Kodak Co., 603 F.2d 263, 274, 276, 287 (2d Cir. 1979).

97 *See* Aspen Skiing Co. v. Aspen Highlands Skiing Corp., 472 U.S. 585 (1985) (imposing liability where defendant denied access to product generally available for sale).

98 Verizon Commc'ns Inc. v. Law Offices of Curtis V. Trinko, LLP, 540 U.S. 398, 411-15 (2004).

99 An alternative strategy is to characterize the conduct as tying or predation. *See* Robinson, *supra* note 86, at 1178 (arguing that opportunities to recharacterize are pervasive).

comparative simplicity of the zero-price rule—that it does not require detailed price regulation[100]—is misleading. If an access provider with a content affiliate reduces quality without raising prices, that form of discrimination will be difficult to observe, much less to establish in a judicial or administrative proceeding. A zero-price rule necessitates an administratively difficult inquiry into the quality of access granted.[101]

In short, even if (as we have assumed) a parallel refusal to deal creates a net social harm, and even if antitrust liability does not extend to that case, a zero-price rule is difficult to understand as a response to the resulting Vonage gap.

C. *The Wikipedia Gap: Exclusion of Social Production*

The Vonage example raises a general issue. Where an access provider is able to collect profits from one content provider but not its rival,[102] the access provider has an incentive to exclude the latter content provider. Social production presents a second situation where an inability to extract creates an incentive to exclude, and in which parallel action by access providers can have a large aggregate effect. As explained in this section, social production has distinctive features that make it unusually valuable, but also unusually vulnerable, to a particular form of exclusion. That mechanism of exclusion is not subject to the prohibitions of antitrust law, moreover, presenting a relatively stronger argument for regulation.

1. Distinctive Features of Social Production

Up to now, we have assumed that content is provided by an ordinary market actor, such as YouTube, Vonage, or the *New York Times*. But socially produced content is a distinctive source of Internet content. Social production, as I use the term, entails collaboration by a large number of decentralized, unpaid individuals, who derive utility from producing despite—or because of—the lack of direct financial incentive. The major conditions for success are that

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100 A zero-price rule sidesteps the concern raised by Owen, *supra* note 18, at 2, that "[n]et neutrality policies could only be implemented through detailed price regulation."

101 A more aggressive solution to the incentive to favor affiliated producers is line of business restrictions. The most famous example is the AT&T government consent decree. United States v. AT&T, 552 F. Supp. 131, 224 (D.D.C. 1982), *aff'd sub nom.* Maryland v. United States, 460 U.S. 1001 (1983). This solution has drawbacks of its own, including the limits it imposes upon efficient vertical integration. For a summary of this debate, compare Mark A. Lemley & Lawrence Lessig, *The End of End-to-End: Preserving the Architecture of the Internet in the Broadband Era*, 48 UCLA L. REV. 925, 940-46 (2001) (advocating separation in the context of broadband carriers and Internet service providers), with Farrell & Weiser, *supra* note 43, at 100-05 (noting efficiency of vertical integration and incentives to maximize overall value), and James B. Speta, *A Vision of Internet Openness by Government Fiat*, 96 NW. U. L. REV. 1553, 1565-66 (2002) (reviewing LAWRENCE LESSIG, THE FUTURE OF IDEAS: THE FATE OF THE COMMONS IN A CONNECTED WORLD (2001)) (similar).

102 Or capture the surplus by raising the access price to consumers. *See infra* Section III.A.

the inputs to production are decentralized (or else public goods) and that the overall project can be subdivided effectively.[103] Examples include the collaborative encyclopedia Wikipedia and distributed computing projects such as Folding@home.[104]

Social production has a distinctive virtue and, in some circumstances, a distinctive vulnerability. The virtue is that social production can be more efficient than market production, in part because it avoids transaction costs in the sharing of excess capacity (for example, computer processing cycles and leisure hours).[105] The vulnerability arises when social production competes with market-produced Internet content, and exclusion by a broadband access provider is feasible. Wikipedia, for example, competes with Encyclopedia Britannica and other for-profit encyclopedias. (The present analysis thus excludes many other forms of "social" collaboration, such as a book club or a family, that do not face that exclusion threat.)

The distinct vulnerability is that a social producer is less able to pay an access fee. The degree of disability varies. Some may be able to raise funds, by charging consumers or accepting advertising. (These and other sources of protection are considered below in Subsection II.C.3.) But fundraising may be impractical due to the transaction costs of raising small amounts of money from each of many users, and the risk that collecting money or permitting advertising will disrupt the nonfinancial *esprit de corps* on which the success of social production, in some cases, may rest.[106] If so, the social producer may be vulnerable to the mechanism of exclusion considered next.

2. Mechanism of Exclusion

Social production alters the competitive dynamic between content providers and access providers. An access provider has an incentive to earn profits from a content provider by offering premium access in exchange for a fee. To fix ideas, suppose Wikipedia and Encyclopedia Britannica offer competing encyclopedias to consumers. An access provider offers faster access at a premium price, and makes this offer available to all interested content providers. Customers prefer faster access, so Encyclopedia Britannica pays the fee. Wikipedia, though offered the same terms, is unable to pay, and loses some customers as a result. Each access provider has the same incentive; for each, it

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103 For a fuller account, see BENKLER, *supra* note 6, at 99-106.

104 *See* http://folding.stanford edu (last visited Apr. 18, 2008). The project uses the spare computing power of distributed users to solve computation-intensive problems related to protein folding, a key step in understanding how misfolded proteins cause disease.

105 BENKLER, *supra* note 6, at 106-16; *see also* Josh Lerner & Jean Tirole, *Some Simple Economics of Open Source*, 50 J. INDUS. ECON. 197, 212-20 (2002) (discussing career concerns and ego gratification as incentives for social production).

106 *Cf.* Uri Gneezy & Aldo Rustichini, *A Fine Is a Price*, 29 J. LEGAL STUD. 1 (2000) (describing how introduction of financial penalties can alter altruistic behavior).

is a dominant strategy to offer the premium service and for Encyclopedia Britannica to accept.

The aggregate effect of the premium service contracts is to deprive Wikipedia of scale. If fewer consumers look to Wikipedia for answers, then likely fewer will contribute, reducing its quality. More generally, social production will suffer where the content's value enjoys increasing returns to scale. If the provider has significant fixed costs, otherwise covered by charging consumers or accepting advertising (for those social producers that can raise limited funds), reduced access to consumers may undermine its ability to cover those costs.

The exclusionary effect of the premium access contracts can reduce welfare. If social production is excluded or suppressed, society loses the productive advantages that can accompany social production. Nevertheless, antitrust law does not prohibit this welfare-reducing transaction. Each access provider here has an incentive to exclude without agreement among the providers. The incentive does not necessarily depend upon a strategic motivation to impede the socially produced content provider or deprive it of scale. Here, an antitrust enforcer would focus upon the increased consumer satisfaction from faster speeds, and the fact that Encyclopedia Britannica and the access provider would make this agreement, whatever the effect upon Wikipedia. The rationality of this conduct, even without considering the negative effect on Wikipedia, differentiates this situation from a payment by Encyclopedia Britannica made only to cause the access provider to block access to Wikipedia, a payment which would violate antitrust law.[107]

3. Limited Feasibility of Regulation

The welfare-reducing nature of the transaction just described, combined with an absence of antitrust enforcement, implies a gap in existing law, and hence a potential role for a narrowly focused zero-price rule. Unlike the Vonage gap, moreover, the Wikipedia gap cannot be filled with a weaker rule that merely requires an access provider to make any offer generally available to rivals. It is useless to insist that an access provider make Wikipedia an offer it

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107 The vulnerability of social production in its competition with market production is a significant challenge to its viability as a mode of production. *See* Lior Jacob Strahilevitz, *Wealth Without Markets?*, 116 YALE L.J. 1472, 1493-1504 (2007) (reviewing YOCHAI BENKLER, THE WEALTH OF NETWORKS: HOW SOCIAL PRODUCTION TRANSFORMS MARKETS AND FREEDOM (2006)); *cf.* BENKLER, *supra* note 6, at 383-459 (describing a wide variety of policy challenges to social production). Strahilevitz considers several ways in which Encyclopedia Britannica might pose a challenge to Wikipedia, including the insertion of deliberate errors, Strahilevitz, *supra*, at 1497, and (more generally) the purchase of excess capacity on which social production relies, *id.* at 1499. By contrast, the distinct mechanism considered here need not rely upon a deliberate strategy of exclusion by the market producer.

cannot accept. A rule that merely policed the offers made would fail to prevent the social harm.[108]

A zero-price rule, implemented where social production competes with market production, amounts to a tailored subsidy for social production. The "subsidy" label is not itself troubling; many protective regulations, including antitrust law, provide effective subsidies to their beneficiaries. Nor is a narrow zero-price rule merely a subsidy to support amateurs, vulnerable to Coase's acid quip that "an amateur is someone who does not pay for the things he uses."[109] The underlying premise is that social production brings distinctive economic benefits, described above, that merit protection if regulation can be accomplished at acceptable cost.

Moreover, much social production has no plausible claim to protection. First, new regulation has no place where the social producer can collect substantial fees from users. In some circumstances, fee collection will be feasible; social producers can and do pay some bills.[110] Second, new regulation has no place where the access provider is able to collect fees from users, for if so, exclusion is no longer a more profitable strategy for the access provider.[111]

Third, new regulation has no place where the social producer has powerful market complementors. Where a market producer benefits from the success of social production, it has an interest in preserving the success of the social producer. It will assist in the implementation of counterstrategies that undermine exclusion.[112] For example, IBM has an incentive to protect Linux as a complement to certain IBM businesses. Similarly, open-source programmers who write code to make the online community Second Life more accessible to disabled people are in little danger, given the interest of Linden Lab, Second Life's owner, in preserving their success.[113]

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108 Nor would the line-of-business restriction considered in Section II.B help. A still narrower rule, however, is possible: to prohibit charges only as to the socially produced content, while permitting access charges to the rival market-produced content. That narrower rule would increase the effective subsidy to socially produced content at the expense of market-produced content.

109 *See* R. H. Coase, *The Federal Communications Commission*, 2 J. L. & ECON. 1, 37 (1959). The subject was a then-novel proposal to create property rights in electromagnetic spectrum, and Dallas Smythe, a former chief economist of the FCC, had presented a series of objections, such as the displacement of current users, including radio amateurs, "which by definition could hardly be expected to pay for frequency use." Dallas W. Smythe, *Facing Facts About the Broadcast Business*, 20 U. CHI. L. REV. 96, 99 (1952). Coase's quip was part of a critique of Smythe's views.

110 *See, e.g.*, What We Need the Money For, http://wikimediafoundation.org/wiki/what_we_need_the_money_for (last visited Apr. 18, 2008) (describing uses of donations to Wikipedia); Wikimedia Fundraising, http://fundraising.wikimedia.org (last visited Apr. 18, 2008) (listing donations).

111 User fees, whether levied by the social producer or the access provider, are more feasible where the value to each user is relatively large and either does not vary too much across consumers or price discrimination is sufficiently effective to capture the variation.

112 *Cf.* Frank H. Easterbrook, *Predatory Strategies and Counterstrategies*, 48 U. CHI. L. REV. 263, 284-88 (1981) (describing a variety of strategic responses to an incumbent's predation).

113 *See* Linden Lab, Open Source, http://secondlifegrid.net/programs/open_source (last visited Apr. 18, 2008) (noting availability of source code for Second Life Viewer).

These three conditions, taken together, cabin the scope of protection to a substantial degree. In those remaining instances where social production faces a market rival, an access provider could be forbidden to charge for premium service where such a charge would create a significant risk of exclusion due to the social producer's inability to pay. It is worth asking, of course, whether new regulation, thus limited, is worth having. An affirmative answer requires confidence in several propositions: that social production offers unique value, that exclusion will cause that value to dissipate rather than shift to similarly valuable but less vulnerable social production projects, that worthy and unworthy claimants to the subsidy can be distinguished,[114] and that a subsidy borne in the first instance by access providers is more efficient than one drawn from general taxation. And there remain the usual difficult questions of implementing a zero-price rule identified in other critiques of network neutrality regulation, including the risk of entrenching the technological status quo, the vulnerability of new regulation to capture, and the loss of transparency that accompanies use of a disguised subsidy through regulation rather than a direct payment. These difficulties are general to all applications of zero-price rules, and do not alter the result that social production provides a *relatively* promising focus for proponents of zero-price rules, compared to market-produced content.

The foregoing analysis demonstrates that Commissioner Adelstein and Google are wrong to look to a zero-price rule as a necessary means to protect content providers generally from exclusion. Regulatory proponents have two options, which are not mutually exclusive. They can narrow their advocacy to protection of socially produced content—an underexplored option—or rely upon a second economic argument for zero-price regulation, that such rules are needed as a response to extraction, to which we now turn.

III. Reconsidering Extraction

Extraction concerns are at the heart of modern advocacy of zero-price regulation.[115] As explained in Part I, the central extraction concern is that when an access provider charges a content provider for access, the content provider's profits fall. The reduction in prospective profits reduces a content provider's incentive to innovate and hence the amount of innovation.

Compared to exclusion, extraction is a more promising ground for regulation, for two reasons. First, antitrust law does not already prohibit extraction. Regulating extraction is the realm of industrial policy, not competition policy. Second, a zero-price rule is better tailored to extraction

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114 As a theoretical matter, if protection of social production were sufficiently important, overinclusion might be tolerated as a second-best measure.

115 *See, e.g.*, Frischmann & van Schewick, *supra* note 63, at 414 n.119 ("Proposals for network neutrality are driven by concerns about a reduction in application-level innovation."); *id.* at 416 n.128 (similar).

concerns than it is to exclusion concerns. The source of the posited problem is the transfer of profits from a content provider to an access provider; the proposed solution is to prohibit transfer. A weaker rule that permits extraction, provided only that the extraction is conducted in an evenhanded manner, does not solve that problem.

As noted in Part I, the extraction argument attracts an immediate response: that not only content innovation but also infrastructure innovation must be taken into account, and that subsidizing content development necessarily comes at the expense of network development. Optimal compensation to the access provider and the content provider is a joint innovation problem. In general, the benefit from an application used in conjunction with a platform—whether a new video game compatible with a console or a new search engine used by broadband consumers—is made possible by two distinct investments. One is the investment made to design and develop the application. The platform owner makes an investment, too, in the infrastructure necessary to deliver or enable the complementary application. These two actions jointly produce incremental value, a point not lost on industry insiders in the network neutrality context.[116]

With a single innovator, there is a benchmark "internalization" solution, in which an inventor is paid an amount equal to the social value she creates.[117] An amount less than full internalization will also induce the invention, provided that it covers the inventor's costs, including her opportunity cost in developing the invention.[118] The internalization solution fails under joint innovation. When two inventors are each but-for causes of an increase in value, paying each of them an amount equal to the increase is problematic for two reasons. First, if payments from users privately fund the innovation, there is not enough compensation to go around. Second, that solution, even if feasible, would inefficiently induce innovation even where it is not cost justified.[119] Joint innovation is a classic, notoriously difficult problem in the regulation of innovation. How best to provide incentives to multiple innovators has been a

116 Verizon CEO Ivan Seidenberg articulated a similar sentiment: "Those guys [Google and Microsoft] gotta use a network. But it's also incredible when you see the innovation that a Google, a Microsoft or an AOL can create. In the long run, Google won't work without us, and we won't work without them." Paul Kapustka, *Verizon Says Google, Microsoft Should Pay for Internet Apps*, INFORMATIONWEEK, Jan. 5, 2006, http://www.informationweek.com/news/showArticle.jhtml?articleID=175801854.

117 Michael Kremer, *Patent Buyouts: A Mechanism for Encouraging Innovation*, 113 Q.J. ECON. 1137 (1998); Steven Shavell & Tanguy van Ypersele, *Rewards Versus Intellectual Property Rights*, 44 J.L. & ECON. 525 (2001).

118 For an argument emphasizing this point, see Brett M. Frischmann & Mark A. Lemley, *Spillovers*, 107 COLUM. L. REV. 257, 276-79 (2007).

119 Suppose that two jointly necessary innovations, which cost a and b to develop, produce social value v. Inducing the innovation is efficient provided $a + b < v$. But the compensation structure discussed in the text induces innovation whenever $a < v$ and $b < v$, even if $a + b > v$.

particular preoccupation of patent scholarship. No consensus answer has emerged.[120]

Four problems, each underappreciated in the existing literature, undercut the extraction-based argument for a zero-price rule. First, zero-price rules prohibit direct extraction but permit more costly indirect extraction, causing implementation of the rule to unravel in practice. Second, nonfinancial motivations to create Internet content reduce the negative effect of extraction on content development. Third, extraction may be a principal component of a plan to increase consumer "spillovers" by subsidizing consumer broadband adoption. Fourth, it has not been established empirically that independent content will be starved for investment without a shift in the regulatory entitlement.

A. *The Indirect Extraction Problem*

A zero-price rule is asymmetric. It prohibits an access provider from charging a content provider to send information to consumers, but permits charging the consumer to receive that information. The AT&T merger condition, for example, prohibits discrimination among content providers, but permits it for consumers desiring different quality of service for a particular kind of data.[121] Network neutrality proponents frequently approve discrimination among consumers.[122]

The appeal of asymmetric regulation is easy to see. Proponents of regulation fear that an access provider will misbehave toward content providers. Regulating the interaction between the two is the most direct response. Moreover, as regulation proponents concede, price discrimination is a useful tool for fixed cost recovery.[123] If the access provider is to take advantage of this tool, yet not discriminate among content providers, it must be able to price discriminate among consumers.

The problem with this view is that asymmetric regulation can unravel. As a general matter, a platform is not limited to access fees as a means to extract profits from an application. It can instead raise its price to consumers to a level

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120 *Compare* SUZANNE SCOTCHMER, INNOVATION AND INCENTIVES 135-42 (2004) (describing circumstances under which upstream inventor is most important to protect), *with* John H. Barton, *Patents and Antitrust: A Rethinking in Light of Patent Breadth and Sequential Innovation*, 65 ANTITRUST L.J. 449, 453-55 (1997) (arguing that downstream inventor is proper focus of protection).

121 The terms of AT&T's commitment apply to discriminatory provision or sales to a content provider, but not to a consumer.

122 *See* Lessig Testimony, *supra* note 63, at 2 (endorsing consumer tiering as means to fund infrastructure development); Lessig AEI Presentation, *supra* note 15, at 24:05 (same); *see also* Atkinson & Weiser, *supra* note 7, at 50 (concluding that "all parties in this debate agree [that] broadband operators should be able to charge *consumers* for different levels of broadband service"); Yoo, *supra* note 33, at 517 (concluding that network neutrality proponents have "conceded the validity of consumer-side tiering"). *But see* Frischmann & Lemley, *supra* note 118, at 297-98 (suggesting that consumer price discrimination is impermissible).

123 *See, e.g.*, Lessig Testimony, *supra* note 63, at 9.

that captures consumers' incremental gains from use of the application. The more the platform charges, the less surplus is left over for the application to capture as profit.[124] In the most extreme version, the platform captures all of the surplus created by the application, forcing the application to sell at cost.[125]

A platform's choice of strategy depends upon the web of ongoing financial relationships among the platform, application, and consumer. For example, where the platform lacks an ongoing financial relationship with the consumer, an access charge levied upon the application provider is easier to implement—a game console maker can more readily charge game makers a royalty on each game sold, rather than charge consumers for each game purchased. Setting a high consumer access price is an attractive alternative where the platform has an ongoing financial relationship with the consumer,[126] and the consumer has a relationship with the application.[127]

A zero-price rule that bans direct extraction through an access charge leaves open indirect extraction through a higher consumer access price, and a rational access provider will take advantage of this loophole. An access provider might offer customers, for a fee, higher-quality access to a particular type of content, such as video streaming or search results, in the expectation that content providers will compensate the consumer for the higher price. To continue the taxation analogy, it is as though policymakers had implemented a value-added tax and decided to shift collection of the tax from sellers to buyers. That shift does not change the incidence of the tax.

Compensation can take several forms. Content providers already compensate consumers directly to use their services. Some firms have paid customers for the privilege of connecting them to advertisers.[128] Microsoft has announced a plan to pay companies to use its search product.[129] Some

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124 Rey & Tirole, *supra* note 41, at 2186; J.A. Ordover et al., *Nonprice Anticompetitive Behavior by Dominant Firms Toward the Producers of Complementary Products*, *in* ANTITRUST AND REGULATION: ESSAYS IN MEMORY OF JOHN J. MCGOWAN 115, 116-17 (Franklin M. Fisher ed., 1985).

125 Rey & Tirole, *supra* note 41, at 2186 (considering a model in which the platform owner sets the price first, capturing surplus and forcing the application to sell at cost); Farrell & Katz, *supra* note 54, at 414 & n.4 (similar).

126 In practice, the console maker may enjoy a continuing relationship with the consumer through the sale of warranties, downloadable legacy games, and access to online gaming networks.

127 In effect, a "two-sided" market becomes "one-sided." For a technical exposition, see Rochet & Tirole, *supra* note 5, at 648 (one-sidedness exists where the volume of transactions depends only upon the price level, not the price structure). *See infra* Section III.C for further discussion of two-sided markets.

128 *See, e.g.*, Ariana Eunjung Cha & Leslie Walker, *A Pyramid Marketing Ploy Clicks*, WASH. POST, Dec. 8, 1999, at A1 ("AllAdvantage and dozens of other companies are rushing to build big audiences by handing out cash to people willing to let advertisers track their Web surfing and send them ads tailored to their habits."). This strategy, however, has not proved particularly successful. *See* Posting of Duncan Riley to TechCrunch, http://www.techcrunch.com/2007/12/10/agloco-doesnt-pay-to-surf-joins-deadpool (Dec. 10, 2007) (describing demise of a successor to AllAdvantage).

129 *See* Thomas Claburn, *Microsoft Pays Enterprise Customers to Adopt Windows Live Search*, INFORMATIONWEEK, Mar. 16, 2007, http://www.informationweek.com/news/

compensation is less explicit, as with advertising exposure that is traded for free content.[130] Compensation could also take the form of a decrease in the amount consumers would otherwise pay the content provider for a particular service.

The strategy applies not only to content providers that earn profits by charging consumers, but also to content providers that profit by charging third parties such as advertisers or by reducing costs through online rather than face-to-face transactions. The access provider can capture these gains, too, through careful consumer pricing.[131] For example, suppose that a consumer receives a benefit of 40 from using a particular type of content, plus an additional benefit of 60 from access to all other types of content. Each provider of the particular type of content receives no revenue directly from consumers but earns 50 from advertising. A zero-price rule prevents the access provider from charging the content provider directly for access.

If the access provider sets a price to consumers of 100, it captures the consumer's gain but not the content provider's profits. But the access provider can do better by charging a price of 150. This is more than the consumer's benefit of 100, and so the consumer will not purchase access (and thereby access the content) unless compensated 50 to do so. But the content provider will have the necessary incentive to pay the consumer 50—for without the consumer, it cannot reap the benefit of advertisement—in order to make the overall transaction worthwhile. This is an extreme example, in which the entire benefit is handed to the access provider, but the point is general. In this way, indirect extraction induces the content provider to offer consumers a negative price, as in the Microsoft example.

Nor does this technique exhaust the instruments of indirect extraction. An access provider, prohibited from charging an access fee, could invest in the development of a competing application. The goal is not to reduce independent content development—though this may be a byproduct—but rather to put downward pressure on the price charged, thereby increasing the consumer surplus that the access provider can capture.[132]

Indirect extraction undermines the effectiveness of a zero-price rule as an instrument for preventing direct extraction. If an access provider captures profits by charging consumers based upon the content used (in anticipation of content provider reimbursement of the consumer), rather than charging the content provider directly, there will be a reduction in content provider profits,

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showArticle.jhtml?articleID=198001615 (describing plan to pay businesses on a per-PC basis for use of Microsoft's Live Search product).

130 The compensation is particularly clear when the exchange is sequential rather than simultaneous, as with Salon's Ultramercials. Stefanie Olsen, *Salon: Watch Ad, Read Articles For Free*, CNET NEWS.COM, Nov. 20, 2002, *available at* http://www.news.com/2100-1023-966664.html.

131 *Cf.* van Schewick, *supra* note 46, at 342-45 (concluding that content provider profits earned from advertising can be extracted by an access provider only through vertical integration).

132 *See, e.g.*, Ordover et al., *supra* note 124, at 116-17.

the very effect that a zero-price rule aims to prevent. Moreover, because indirect extraction has a tendency to restore the status quo, critics of zero-price rules may not see their fears materialize.[133]

At the same time, the access provider's resort to indirect extraction creates several new sources of social cost. Those costs include the implementation of the indirect extraction scheme and countermeasures by consumers and content providers to insulate themselves from indirect extraction. In tax terms, shifting the collection from sellers to buyers can alter the cost of collection, independent of the tax's incidence. As a matter of theory, it is uncertain whether these costs are greater than the costs of implementing a direct extraction scheme and of countermeasures employed by content providers to insulate themselves from direct extraction.

Indirection does not undermine zero-price regulation aimed at exclusion, or at least not to the same extent. Indirect exclusion, to be effective, requires a narrowly focused deal between an access provider and a consumer that favors one content provider over its rival. But that level of specificity will be difficult to implement. For one thing, an explicit contract implementing that discriminatory deal would raise antitrust concerns, for the reasons discussed in Part II. Moreover, if an access provider is limited, as a legal or practical matter, to consumer pricing that varies with the type of content and intensity of use, but not the particular content provider, then indirect exclusion will be difficult to implement.

B. *Nonfinancial Incentives to Develop Content*

A tax on innovative content burdens both startups and established firms. Some advocates worry that this burden will disproportionately fall upon startups.[134] But this is not a necessary outcome. First, it is not clear what constitutes a disproportionate burden. Extraction, from the content provider's perspective, resembles an electrical bill or building rent, and we would not normally think of these latter categories as posing an unusual, disproportionate burden upon a startup content provider that ought to be remedied by requiring the service provider to provide a discount or rent abatement.

Moreover, the relative burden depends upon the fine detail of the access charge—a lump sum versus a percentage of profits, or a graduated scale

133 For a representative example of such fears, see Sidak, *supra* note 50, at 351-52 (arguing that network neutrality regulation will deny access to consumers with low willingness to pay).

134 For example, Lessig writes:

> [I]t will be the new innovators who bear the burden of these taxes most heavily. The point is obvious when you think about the history of YouTube. Had network owners been charging an access premium, investors in an upstart like YouTube would have had good reason to think twice. All taxes are a barrier, but this tax would be a particularly high barrier to innovation. It would hinder newcomers such as YouTube by favouring established companies such as Google and Yahoo.

Lessig, *Congress*, *supra* note 64.

indexed to use of the network. An access provider has a strong incentive to maximize the value of complementary applications.[135] An access provider has an incentive to "soak the rich," whose investments are already sunk, rather than fledgling firms that are a source of future profits—or a source of competition to other content providers, ultimately making more surplus available for capture by the access provider.

That prospect might nevertheless have some chilling effect on a fledgling content provider that makes decisions based upon the probability of future great wealth. This concern, however, is undermined by a particular feature of content development: nonfinancial incentives to create content. Much of the celebrated explosion of new tools and services on the Internet has required no financial motivation. Wikipedia's contributors have built a powerful encyclopedia without compensation.[136] Blogs have emerged on every possible subject, often (though not always) without a direct financial motive. The millions of users whose contributed content populates YouTube, MySpace, and Facebook are not compensated.

Moreover, leading Internet businesses that have profit-making at their core today had non-financial origins. Pierre Omidyar started eBay and Jerry Yang organized the link list that became Yahoo as hobbies.[137] Sergey Brin and Larry Page developed Google's original search algorithm as a research project, in part to solve an academic puzzle not itself about search.[138]

Thus, some content innovation is relatively insensitive to the charging of a toll. For some content, permission to extract makes no difference because there's nothing to extract or the amounts are too small to feasibly collect. For others, charging a toll will have only a limited effect. For MySpace and Facebook, payment of some profits to a network provider would reduce the firm's profits but not necessarily alter the incentives of individual users. eBay, Google, and Yahoo likely would have flourished even if their founders had anticipated a "network tax" if they achieved extreme financial success.

This point has an analogue in discussions of optimal patent policy. Some innovation can be elicited without expectation of financial compensation. Some low-effort ideas will be supplied by inventors even without payment. Non-market financial incentives, such as government and university research grants, compensate other inventors. Moreover, innovation is often induced by nonfinancial rewards, including the thrill of discovery, satisfaction from

135 *See infra* Section III.D for further discussion.

136 Jim Giles, *Internet Encyclopaedias Go Head to Head*, 438 NATURE 900 (2005).

137 *See* Saul Hansell, *Creator of the On-Line Swap Meet*, N.Y. TIMES, Nov. 15, 1998, at BU2 (describing how Omidyar began eBay "on a lark"); Verne Kopytoff, *It Started as 2 Guys in a Trailer; Yahoo Stands as One of Internet's Biggest Success Stories*, S.F. CHRON., Feb. 28, 2005, at E1 (describing Yahoo's "hobby" origins).

138 *See* JOHN BATTELLE, THE SEARCH: HOW GOOGLE AND ITS RIVALS REWROTE THE RULES OF BUSINESS AND TRANSFORMED OUR CULTURE 65-93 (2005) (describing Stanford research project exploring backlinks that became PageRank).

winning a competition, and the esteem of peers. Where an invention would have been made nearly as quickly without patent protection, the need for protection diminishes.[139]

The concern about incentives is particularly muted where the startup costs are low.[140] To be sure, even such a firm may eventually require a massive infrastructure in order to achieve success. Amazon, eBay, Google, and Yahoo, like YouTube, MySpace, and Facebook, require large investments to set up the servers, connectivity, and support necessary for scale. Without a prospect of profit, investors would not make this capital available. But in this respect, content provision lacks a distinctive claim to a subsidy. Its investors are identical to those making infrastructure investments on the network side. Investments in content provider infrastructure may be dulled by the payment of a toll, and the tradeoff to be made is between content provider infrastructure and access provider infrastructure.

C. *Extraction as a Means to Increase Consumer Spillovers*

Extraction, aside from having a relatively small negative effect upon the development of some content, may be a key component of a strategy to increase consumer broadband adoption. Scholars have described broadband access as a source of positive consumer spillovers.[141] Connectivity permits individuals to consume and produce creative content and fosters the development of social capital. The value may not be capturable by an access provider or content provider because it is unobservable, is beyond the grasp of feasible price discrimination, accrues partly to other users rather than the immediate consumer, or escapes the notice of the consumer and hence is not included in her willingness to pay.[142] Although this economic dark matter is

139 *See, e.g.*, Graham v. John Deere Co., 383 U.S. 1, 11 (1966) (understanding patentability standard as a way to "wee[d] out"—that is, restrict patentability to—"those inventions which would not be disclosed or devised but for the inducement of a patent"); Roberts v. Sears, Roebuck & Co., 723 F.2d 1324, 1346 (7th Cir. 1983) (Posner, J., dissenting) ("[I]f a court thinks an invention for which a patent is being sought would have been made as soon or almost as soon as it was made even if there were no patent laws, then it must pronounce . . . the patent invalid.").

140 Randall Stross, *The Human Touch That May Loosen Google's Grip*, N.Y. TIMES, June 24, 2007, at BU3 ("The combination of low start-up costs and potentially huge profit makes [search startups] seem a reasonable bet."); *see also* Wu Testimony, *supra* note 64, at 56 (noting that for many Internet businesses, "startup costs are minimal: many successful business[es] began with just an idea and a good web site").

141 *See, e.g.*, Frischmann & Lemley, *supra* note 118, at 279 ("[T]he demand-signaling function . . . does not necessarily work well when purchasers use a resource as an input . . . ."); *id.* at 293-98 (applying this argument to network neutrality).

142 Brett M. Frischmann, *An Economic Theory of Infrastructure and Commons Management*, 89 MINN. L. REV. 917, 1017-20 (2005).

difficult to quantify, careful students of the phenomena have reckoned the benefits to be large.[143]

There are two ways to increase the consumer benefits of broadband usage. One is the intensive margin: increasing the welfare of an existing broadband user. The other is the extensive margin: turning a nonuser into a user. The latter strategy seems promising, in part because consumer adoption of broadband in the United States has significantly lagged behind that of other countries. As of the end of 2006, U.S. adoption reached 20 connections per 100 people, fifteenth among surveyed countries and less than two-thirds the penetration of Denmark, the world leader.[144]

In particular, access providers could subsidize consumer adoption by charging content providers for access.[145] AT&T's pitch might be: "We're committed to pervasive broadband service, and to making access available to the millions who lack such service, by asking successful content providers to tithe a fraction of their profits, to be applied toward the provision of new consumer access." This strategy would increase consumer-side spillovers but violate a zero-price rule. The attractiveness of this proposition runs counter to the assertion, sometimes made, that a zero-price rule is necessary to preserve consumer spillovers.[146]

The access provider is particularly well positioned to coordinate a strategy that promotes broadband adoption. To be sure, content providers have a substantial collective incentive to increase adoption rates, in order to enjoy a larger market for their products. But any particular content provider will capture only a small part of the gain from recruiting a new broadband consumer, and the content providers, taken as a whole, will face a tragedy of the commons in dividing the total subsidy burden among themselves. Here the access provider may play a useful role by orchestrating the contributions of the different content providers.

A consumer subsidy strategy has plenty of precedents where markets are "two-sided"—that is, where a firm enables interactions between different types

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143 *See id.* at 1017-19; Frischmann & Lemley, *supra* note 118, at 296-98; *see also* R. Polk Wagner, *Information Wants to Be Free: Intellectual Property and the Mythologies of Control*, 103 COLUM. L. REV. 995 (2003).

144 *See* ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, OECD BROADBAND STATISTICS TO DECEMBER 2006 (2007), *available at* http://www.oecd.org/document/7/0,3343,en_2649_34225_38446855_1_1_1_1,00.html (reporting, as of December 2006, 19.6 connections per 100 people in the United States and 31.9 in Denmark). If the figures are normalized by household, the overall U.S. ranking changes hardly at all. One calculation, using June 2006 OECD data, places the United States twelfth on both a per capita and a per household basis. *See Digital Future of the United States: Part IV: Broadband Lessons from Abroad: Hearing Before the Subcomm on Telecommunications and the Internet of the H. Comm. on Energy and Commerce*, 110th Cong. 17 tbl.2 (2007) (testimony of George S. Ford).

145 For an argument along similar lines, see Sidak, *supra* note 50, at 462 (noting that if end users pay the full cost of access, some consumers will be excluded).

146 *E.g.*, Frischmann & Lemley, *supra* note 118, at 298 (concluding that "[p]reserving Internet spillovers requires preserving network neutrality").

of end users.[147] A difficult challenge in such markets is to set prices to attract both sides to the table. A common strategy is to combine high prices toward one side of the market with subsidization of the other.[148] Game console makers offer the console at a loss[149] but earn profits from royalties paid by developers;[150] credit card payment systems charge merchants but subsidize consumers in the form of cash or frequent flyer miles; women pay less than men to enter certain nightclubs.[151] Internet service provider NetZero adopted the same plan when it offered free dial-up Internet access to consumers but required them to watch advertising.[152] Google does the same when it charges advertisers but not users of its search engine.

The lack of a zero-price restriction upon the pricing behavior of credit card payment systems, video game consoles, and other platform providers promotes widespread adoption of each technology. Where, as with broadband service, an access charge for content providers is not likely to be entirely passed on by content providers to the customer,[153] a zero-price rule can have an inhibitory effect upon adoption. That is not to say that a zero-price rule is necessarily inimical to broadband access. The present point is simply that a zero-price rule is not essential to a robust broadband access policy.

D. *Contracting into Decentralized Innovation*

Resting the argument for a broad-based zero-price rule on extraction concerns encounters a further problem. Advocates of zero-price regulation rightly emphasize the value and importance of decentralized content innovation. But there is reason to expect that even if access providers have a measure of control over the path of complementary content innovation,[154] they will use that control to promote decentralized innovation. By "contracting into"

147 For an introduction, see Rochet & Tirole, *supra* note 5.

148 *Id.* at 659 (noting, as examples, giving away Acrobat reader to make money from writers, giving away newspapers to increase advertising, and below-cost video game consoles).

149 *See, e.g.*, Press Release, iSuppli, PlayStation 3 Offers Supercomputer Performance at PC Pricing (Nov. 16, 2006), *available at* http://www.isuppli.com/news/default.asp?id=6919 (reporting result of teardown analysis of PlayStation 3 game console). The premium model of the console has an estimated materials cost of $840 and a suggested retail price of $599. The basic model has an even wider discrepancy.

150 DAVID S. EVANS ET AL., INVISIBLE ENGINES: HOW SOFTWARE PLATFORMS DRIVE INNOVATION AND TRANSFORM INDUSTRIES 135 (2006) (reporting $7 per unit royalty for Xbox games made by third parties).

151 Lauren Collins, *On the Docket: Hey, La-a-a-dies!*, NEW YORKER, Aug. 6, 2007, at 22 (describing an equal protection challenge to lower admission fees for women at New York clubs).

152 NetZero later moved to a pricing structure based upon user fees.

153 If the access charge to the content provider is passed through entirely to the customer, then the policy has no effect on adoption.

154 As opposed to content that competes with a legacy business, as discussed *supra* in Section II.B.

decentralized innovation,[155] an access provider will implement, as a private matter, the same basic arrangement that zero-price advocates seek through government intervention.

The flourishing of attractive content is in an access provider's interest because it raises the surplus that can be extracted by the access provider. One option is for an access provider to attempt to make attractive content on its own. This strategy is likely to fail because innovative content ideas are widely dispersed.[156] Someone will invent PageRank,[157] but any particular access provider is unlikely to come up with that innovation even if it exerts considerable effort. A large incumbent may find it particularly difficult to develop innovative content in-house. Its culture may resist new approaches, and its relatively flat pay structure makes it difficult to provide large rewards to financially motivated individual innovators. The problem is worsened if the access provider is an incompetent steward and exercises control in an irrational or arbitrary way.[158]

The dispersed nature of innovation implies the failure of in-house content production. Decentralization is necessary. But it does not follow that *government-mandated* decentralization will increase the production of innovative content. Even if a content provider lacks a regulatory entitlement to retain a certain level of rewards from its innovation, the access provider has a strong incentive to furnish those rewards. Where the interests of the access provider and the content provider can be aligned in this fashion, the initial distribution of regulatory entitlements does not matter. This is a familiar argument, essentially the Coase theorem in a dynamic setting,[159] well captured by the explicitly Coasean analysis of Owen and Rosston[160] and the "internalizing complementary efficiencies" baseline described by Farrell and Weiser.[161]

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155 *Cf.* Stuart Minor Benjamin, *Spectrum Abundance and the Choice Between Private and Public Control*, 78 N.Y.U. L. REV. 2007 (2003); Robert P. Merges, *Contracting into Liability Rules: Intellectual Property Rights and Collective Rights Organizations*, 84 CAL. L. REV. 1293 (1996).

156 For an introduction, see SCOTCHMER, *supra* note 120 (collecting and evaluating literature); Peter S. Menell & Suzanne Scotchmer, *Intellectual Property*, *in* 2 HANDBOOK OF LAW AND ECONOMICS 1473 (A. Mitchell Polinsky & Steven Shavell eds., 2008).

157 PageRank, the "heart" of Google search software, "relies on the uniquely democratic nature of the web by using its vast link structure as an indicator of an individual page's value." Google Technology, http://www.google.com/technology (last visited Apr. 18, 2008); *see also* Sergey Brin & Lawrence Page, *The Anatomy of a Large-Scale Hypertextual Web Search Engine*, 30 COMPUTER NETWORKS & ISDN SYS. 107 (1998) (describing PageRank).

158 Farrell & Weiser, *supra* note 43, at 114-17.

159 *See, e.g.*, Guido Calabresi, *Transaction Costs, Resource Allocation, and Liability Rules—A Comment*, 11 J.L. & ECON. 67 (1968) (acknowledging applicability of Coase theorem to dynamic entry decisions).

160 *See* Owen & Rosston, *supra* note 49, at 167-68 (suggesting the utility of a Coasean perspective).

161 Farrell & Weiser, *supra* note 43; *cf.* Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265 (1977).

There are theoretical reasons to think that the dynamic Coase theorem does not always hold. For example, a content provider might worry that once it sinks the costs of application development, it will be subject to "holdup," or expropriation of its profits by the access provider. The holdup problem is not limited to content providers. For example, an access provider's investment in capacity makes later content development possible. When it comes time to divide the surplus jointly created by the new capacity and the new content, the access provider's previously sunk costs are not part of the bargain.[162] This dilemma of sequential innovation creates a significant difficulty for access providers—for example, Verizon, during its continuing fiber-to-the-home rollout[163]—seeking to recover fixed costs expended to develop a joint innovation.[164] A zero-price rule worsens that cost recovery problem.

How well do access providers contract into decentralized innovation? Direct evidence on this question is lacking.[165] The technical ability of an access provider to engage in extraction is only now emerging, and so we lack a track record of negotiations between access providers and content providers succeeding or failing. It has not been established, moreover, whether an access provider can simply precommit to a menu of charges that varies depending upon the size and success of the content provider, a step that would reduce the holdup problem. The absence of direct evidence is a reason to resist ambitious regulation, such as a zero-price rule.

Evidence from other industries suggests that the holdup problem is not severe. Recall, for example, the video game developer's royalty payments to the console maker.[166] Movie studios use a variety of contractual instruments to coordinate sequential investments by writers, producers, and actors.[167] Codevelopment relationships ameliorate, as a practical matter, the theoretical

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162 For example, suppose that the access provider makes a capacity investment at a cost of 10, and then a content provider develops innovative content, possible only as a consequence of the earlier capacity investment, at a cost of 5. The benefit created by the two investments is 20. The access provider can anticipate the size of this benefit but not its source. If the two bargain after all costs are sunk, and the two divide the gain evenly, each receives 10, and the investment will proceed. If the access provider's costs are slightly higher, then the access provider will not invest in the first place, and the socially valuable innovation will not be produced. Note that if the content provider can be identified prior to the access provider's investment, the problem is reduced, for in that case the access provider will insist that the content provider help cover those costs.

163 Arshad Mohammed, *Verizon Lays It on the Line: CEO Sticks By Costly Rollout of Fiber-Optic Network*, WASH. POST, Feb. 1, 2006, at D1.

164 *See* SCOTCHMER, *supra* note 120, at 135-40.

165 For a recent statement emphasizing the absence of demonstrated harm, see Ex Parte Filing, U.S. Dep't of Justice, *In re* Broadband Industry Practices, 22 F.C.C.R. 7894 (Apr. 16, 2007) (No. 07-52), *available at* http://www.usdoj.gov/atr/public/comments/225767.pdf.

166 Console makers employ a mix of "make" and "buy" strategies. Sony and Microsoft have worked with outside vendors for the most part. Nintendo has made games on its own, though this is changing. Martin Fackler, *Putting the We Back in Wii*, N.Y. TIMES, June 8, 2007, at BC1. Some games are made for multiple consoles, while others are exclusive to one console.

167 *See, e.g.*, Victor P. Goldberg, *The Net Profits Puzzle*, 97 COLUM. L. REV. 524 (1997).

effect of holdup in automobile manufacturing[168] and other industries.[169] Some firms, such as Intel, promote complementary innovation by making clear commitments to preserve the profitability of complementary markets.[170] A practically-minded literature provides advice about how best to "procure innovation" from outside suppliers.[171]

There are counterexamples, in which privately arranged decentralization has failed. For example, only after the *Carterfone* decision, and the accompanying reduction in AT&T's control of innovations complementary to ordinary telephone service, did applications such as modems and fax machines emerge. There exist historical examples in which a single firm with broad patent protection has controlled an industry, and proved to be a poor orchestrator of later improvements.[172] The relevance of these counterexamples is limited by a common feature: the presence of a single dominant firm with control over an industry.[173] (Nor do all dominant firms threaten complementary innovation, as the Intel counterexample demonstrates.) In broadband access provision, by contrast, no single firm has anything like that level of control. No provider has a U.S. market share larger than 25 percent, and most have much less. The relative unimportance of each access provider increases the competitive pressure to make good decisions about complementary innovation, and reduces the likelihood that any single provider's suboptimal decision will have an adverse effect.[174]

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168 Susan Helper et al., *Pragmatic Collaborations: Advancing Knowledge While Controlling Opportunism*, 9 INDUS. & CORP. CHANGE 443 (2000). Automobile manufacturing is the source of the most famous case of holdup in the literature, the negotiations between General Motors and a key supplier, Fisher Body. Whether that example actually reflects holdup is subject to doubt. *See* Ronald Coase, *The Conduct of Economics: The Example of Fisher Body and General Motors*, 15 J. ECON & MGMT. STRATEGY 255 (2006).

169 *See* Charles F. Sabel & Jonathan Zeitlin, *Neither Modularity or Relational Contracting: Inter-Firm Collaboration in the New Economy*, 5 ENTERPRISE & SOC'Y 388 (2004) (discussing "the profusion of innovative disciplines and practices of co-design such as simultaneous engineering, benchmarking, co-location of personnel, problem-solving teams, processual quality standards, and the like").

170 *See* Gawer & Henderson, *supra* note 5 (providing a detailed account of Intel's efforts to preserve innovation in complementary markets).

171 Luis Cabral et al., *Procuring Innovations*, *in* HANDBOOK OF PROCUREMENT 483 (Nicola Dimitri et al. eds., 2006) (suggesting principles for purchase of innovative goods by public and private entities).

172 *See* Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839 (1990) (offering examples from electrical lighting, automobile, airplane, and radio industries).

173 In addition, some really amount to anticompetitive suppression of substitutes rather than poor strategy in the promotion of complements.

174 *Cf* Bresnahan & Greenstein, *supra* note 5 (making a similar point in the context of "divided technical leadership"). Indeed, an access provider's decision might well have no substantial effect, due to fragmentation among access providers, an effect discussed *supra* in Subsection II.B.1. If a content provider can achieve scale without access to a particular access provider's customers, the access provider has little effect on innovation.

IV. Conclusion

The merits of a zero-price rule that protects content providers generally cannot be sustained. Exclusion concerns are addressed by antitrust law, with the caveats noted in Part II. Extraction grounds fail to justify zero-price regulation for the reasons discussed in Part III, including substitution to indirect extraction, the availability of nonfinancial rewards for content innovation, the virtues of an extraction-reliant strategy for increasing broadband adoption (and, as many have noted, for encouraging infrastructure development), and the absence of evidence that privately negotiated decentralization is infeasible.

This Article's typology of exclusion and extraction, and accompanying analysis of each strategy, are useful tools to assess other claims that a powerful firm has the ability and incentive to limit competition and innovation. Consider, for example, Google, currently the most powerful content provider. The incentives of content providers have been neglected, compared to the extensive recent scrutiny of access providers. A shift in attention is appropriate in part because, as explained in Part II, exclusion of a content provider, an important focus of network neutrality proposals, is of primary benefit to a rival content provider.

Google is a major infrastructural resource that possesses the major features that have traditionally given rise to common carrier regulation. Moreover, Google's bargaining position does not suffer from the market fragmentation that besets an individual access provider, making it a more likely extractor than AT&T or Comcast, extraction that could be undertaken with respect to access providers or complementary content businesses.

As for exclusion, a risk arises where a complementary content business has a contractual or ownership relationship to Google's core search business, and there are incentives to favor that content over rivals in Google's search results. A full analysis is beyond the scope of this Article, but as analysts of network neutrality turn toward the analogous question of search neutrality, three lessons from Part II are particularly relevant.

First, the degree of ownership matters. Anticompetitive favoritism is rendered less visible and less amenable to antitrust enforcement when it is masked within the firm. Google's steady accretion of content affiliates, such as YouTube, news, maps, and financial information, provides a greater opportunity for anticompetitive favoritism. The effect of ownership is compounded by a second factor: the technology of favoritism. Network neutrality concerns have become more important as the technology of traffic differentiation has improved. Search neutrality will become more important as search results become easier to manipulate—for example, with "universal search," in which Google's familiar list of ten blue links is augmented with information from its affiliates.[175] As PageRank cedes ground to Google's own editorial choices, the opportunity for favoritism increases.

Third, social production is particularly vulnerable when rival content offers a superior mechanism for extraction, and alternative mechanisms for collecting surplus (such as charging consumers) are unavailable. As an example, consider Google's newest content affiliate, Knol, still under development as of April 2008.[176] Knol is a proposed for-profit alternative to Wikipedia, in which authors and Google share advertising dollars. Knol gives Google a revenue stream that it misses out on when consumers use Wikipedia instead. As a consequence, Google has an incentive to steer traffic to Knol, even if users prefer Wikipedia.[177] The resulting decrease in Wikipedia traffic might reduce participation in, and hence the quality of, Wikipedia.[178]

Whether anything comes of the Knol initiative, Google's foray does suggest that the "Wikipedia gap" discussed in Part II is not merely theoretical. Nevertheless, even though the narrower case of socially produced content presents a relatively stronger argument for regulation, implementing such regulation in practice requires a better understanding of the circumstances under which alternative mechanisms protect social production. For example, as explained in Part II, effective price discrimination among consumers makes regulatory protection unnecessary, by providing an alternative mechanism by which an access provider can harvest the available surplus, rather than excluding social production. Moreover, other complementors of the socially produced content may be able to engage in counterstrategies that reduce the utility of regulation.

The vulnerability of social production is a general issue. It recurs, for example, in the ongoing high-stakes battle between Linux and Microsoft. Microsoft, a market producer, has secured patents pertaining to operating

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175 comScore reported that during a one-week sample period in January 2008, 17% of Google results included universal search, and more than half of users saw a universal search result. Kevin Ryan, *Uncovering the Real Universal Search*, SEARCH ENGINE WATCH, Mar. 19, 2008, http://searchenginewatch.com/showPage.html?page=3628796.

176 Posting of Udi Manber, VP Engineering, to Official Google Blog, http://googleblog.blogspot.com/2007/12/encouraging-people-to-contribute.html (Dec. 13, 2007, 18:01:00 EST).

177 *See* Nate Anderson, *Google to Wikipedia: "Knol" Thine Enemy*, ARS TECHNICA, Dec. 14, 2007, http://arstechnica.com/news.ars/post/20071214-google-to-wikipedia-knol-thine-enemy.html ("[I]t's clear that Google really wants to be in control . . . . And it can offer something that Wikipedia, et al., cannot: cash."). Interestingly, Google might have an incentive to privilege its affiliate even if this incentive is missing, because the popularity of Knol results are easier to measure. *Cf.* Danny Sullivan, *Google Knol—Google's Play to Aggregate Knowledge Pages*, SEARCH ENGINE LAND, Dec. 13, 2007, http://searchengineland.com/071213-213400.php.

178 Posting of Duncan Riley to TechCrunch, http://www.techcrunch.com/2007/12/14/google-knol-a-step-too-far (Dec. 14, 2007) (describing Knol as "direct challenge to Wikipedia" and arguing that "[i]f Wikipedia is replaced in the first few results on Google with pages from Knol, Wikipedia traffic will decrease, and possibly as a consequence so will broader participation on Wikipedia").

system functionality that Linux might infringe.[179] Linux, the product of social production, has not secured a comparable patent portfolio to threaten Microsoft. This has created a potential strategic disadvantage for Linux, in which it is unable to enforce mutual deterrence with Microsoft.[180] Extending the familiar analogy of nuclear deterrence, in which patentholders engage in mutual abeyance, rather than launching patent infringement suits, the question is whether and when a well-equipped ally will commit to extend its protective umbrella.[181] This Article provides a first step toward a better understanding of the strategic interaction between social production and market production. Identifying the extent and availability of credible counterstrategies is a promising area for future research.

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179 Daisuke Wakabayashi & Jim Finkle, *Microsoft Says Open Source Violates 235 Patents*, REUTERS, May 15, 2007 (reporting Microsoft's contention that open-source software violates 235 company patents and intention to seek licensing fees).

180 *See* Roger Parloff, *Microsoft Takes on the Free World*, FORTUNE, May 28, 2007, at 76.

181 Matthew Broersma, *Google Joins Open-Source Patent Network*, ZDNET NEWS, Aug. 8, 2007, http://news.zdnet.com/2100-9595_22-6201407.html; Martyn Williams, *IBM, Sony, Red Hat Join Others in Linux Patent Venture*, INFOWORLD, Nov. 10, 2005, http://www.infoworld.com/article/05/11/10/HNlinuxpatent_1.html.

THE INTERNET ECONOMY 25 YEARS AFTER .COM

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If one read only the mainstream media, one might not be blamed for thinking that the dot-com revolution is principally about Web 2.0 applications such as Twitter, Facebook, or Wikipedia. But while certainly interesting and useful, these kinds of applications represent only a small fraction of the impact of the "commercial Internet." In fact, in the 25 years since the first .com, Symbolics.com, leapt onto the world stage on March 15, 1985, the commercial Internet has revolutionized businesses, economies, and societies throughout the world.[1] The Internet economy has spawned a multitude of innovative "dot-com" companies; unleashed entirely new business models; spurred the creation of new products and services; changed how consumers shop; transformed how corporations sell their products and procure their inputs; boosted economic growth; and fundamentally altered how individuals interact, build communities, and socialize.

As of September 2009, an estimated 1.7 billion of the world's 6.7 billion citizens (25.6 percent) use the Internet, with usage growing 380 percent from 2000 to 2009.[2] It's now hard to remember a time when the Internet and dot-com Web sites were not part of daily life. Yet, just 15 years ago, there were only 18,000 Web sites, while today there are more than 80 million .com domain names alone. With this extraordinary migration to "life online" as a backdrop, this report analyzes and catalogs the Internet's myriad and ever-growing benefits to consumers and businesses alike from what is known as the Internet (or "dot-com") economy.

Over the last 25 years, the use of .com domain names has expanded rapidly from a specialized name space for the high-tech community to an integral part of the global economy. Notwithstanding the collapse of the dot-com bubble, since the end of 2000 the number of registered .com domain names has increased dramatically, with 668,000 new .com domains registered, on average, each month. Moreover, while 21 million .com domain names were registered between 1985 and 2000, in just the ten years since 2000, close to 60 million more have been registered. And the overall query load (individually accessed .com and .net Web pages) per day has increased from 14 billion queries in 2004 to 49 billion in 2009.

ITIF estimates that the annual global economic benefits of the commercial Internet equal $1.5 trillion, more than the global sales of medicine, investment in renewable energy, and government investment in R&D, combined.[3] And if e-commerce continues to grow even just half as fast as it grew between 2005 and 2010, then by 2020 global e-commerce will add $3.8 trillion annually to the global economy—more than the total GDP of Germany. While the share of e-commerce conducted just through dot-com domains is smaller, ITIF estimates that it is still substantial, generating an estimated $400 billion in economic benefits annually throughout the world, an amount that is expected to grow to $950 billion annually by 2020.

The commercial Internet is transforming economies throughout the world. Across Europe, the percentage of dot-com shoppers grew by 85 percent between 2004 and 2009. In Korea, 32 percent of Internet users over the age of six regularly post to their own blogs. In the developing world, Internet users are almost as likely to have shopped online as their developed world counterparts; for example, 63 percent of Latin Americans and 70 percent of those in the Asia Pacific region have made at least one purchase online, compared to 85 percent of Internet users in both North America and Europe. While in all nations e-commerce is growing, some countries have taken the lead. ITIF assessed 30 nations on seven indicators, finding that four, Denmark, Sweden, the United Kingdom, and the United States, are in a group by themselves, leading the world in e-commerce.

The economic benefits conferred by the commercial Internet accrue to consumers, workers, businesses, and economies writ large. The commercial Internet helps consumers by making markets more efficient by expanding consumer access to information; lowering prices, both by enabling self-service opportunities and by allowing businesses to pursue lower-cost business models; expanding consumer choice; and helping to hold businesses accountable for high-quality products and services. Likewise, the commercial Internet helps workers by boosting wages and facilitating more efficient labor markets.

Moreover, the Internet economy boosts economic growth in a variety of ways. It enables firms to become more efficient and to raise productivity, thereby allowing consumers to save money or workers to earn more (or both), both of which boost GDP. The Internet economy also enables more efficient allocation of goods and services, for example, by enabling auction or matching markets for an almost infinite variety of products, skills, and services, helping allocate them to the parties that value them the most, whether they are personal memorabilia on eBay, professional skills at Monster.com, or solutions to innovation challenges at InnoCentive. The dot-com economy also empowers the development of entirely new business models. For example, the commercial Internet empowers mass customization business models, for everything from Dell's build-to-order PCs over the Web to custom-designed Mini automobiles and Nike shoes. It has also enabled a range of software-as-a-service and cloud-based business models, such as the Web-based customer relationship management services offered by Salesforce.com. It also gives firms, especially small businesses, access to larger markets from down the street to across the globe.

Finally, businesses involved in enabling the dot-com economy contribute directly and substantially to economies, accounting, for example, for 2 percent of employment in the United States, with wages equaling 2 percent of U.S. GDP.[4]

The commercial Internet also delivers a wealth of non-economic benefits by: expanding information availability and access, including placing vast amounts of information online; increasing access to health information and even health services; providing "always available" online education opportunities; building communities by facilitating social interactions; offering more entertainment choices; and fostering a more sustainable, energy-efficient environment.

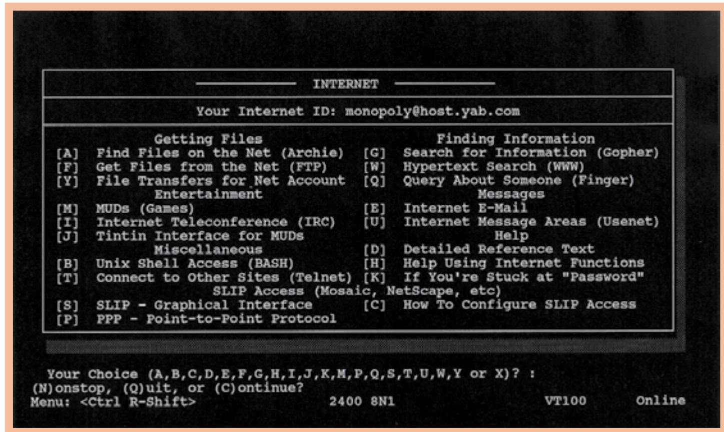
The global diffusion of the commercial Internet has occurred with astounding speed. Every country on Earth, developed and developing alike, has adopted the Internet. And while the dot-com bust of the early 2000s might have led some to believe that the Internet was merely a passing fad—the same way that those who derisively heckled car drivers with taunts of "get a horse" in the 1920s thought that automobiles were a passing fad—in fact, the dot-com start-ups of the late 1990s, as a whole, have actually achieved higher survival rates than most new technology start-ups throughout history have (and certainly higher rates than for most new start-up businesses in general). Moreover, what even the spectacular failure of once dot-com luminaries such as Webvan.com, pets.com, or Broadcast.com masks is that the services those companies envisioned offering over the Internet have indeed since come to fruition, even if delivered by competitors or other companies that crafted a more sustainable business model. For example, Webvan may have failed, but U.S. grocer Giant offers Peapod, an online grocery and delivery service. In short, despite the bursting of the "dot-com bubble" in the early 2000s, the Internet economy has subsequently more than fulfilled its initial promise to transform both the economy and society, and there appears to be no end in sight.

And more is likely to come. Future trends in the Internet economy will include ever greater adoption of existing technology, as more citizens and businesses around the world come online and engage in e-commerce; greater use of self-service technology; more high-bandwidth applications; greater use of the mobile Internet; the growth of location-based services; and new Web-based applications that enable a smarter world. For example, "smart home" technologies will enable individuals to use the Internet to control their lights from a laptop, turn on their heaters using their iPhone, and schedule recordings on their TiVos remotely.

In total, surveying the 25 years since the first .com domain name was registered, one can rightly describe the commerical Internet as a general purpose technology (GPT), one whose significance to society should be viewed as on par with the advent of inexpensive steel, the telephone, the internal combustion engine, or electricity. Whereas the telegraph represented a global network for communication of short written messages, and the telephone a global network for voice communication, the Internet represents a unified global network for voice, data, and video. But even more than that, the Internet provides a fundamentally new digital infrastructure platform through which global commerce can occur.

General purpose technologies such as the Internet, which historically have appeared at a rate of once every half century, represent fundamentally new technology systems that change virtually everything, including what economies produce; how they produce it; how production is organized and managed; the location of productive activity; the skills required for productive activity; the infrastructure needed to enable and support it; and the laws and regulations needed to maintain, or even to allow, it.[5] GPTs share a variety of similar characteristics. They typically start in relatively crude form for a single or very few purposes; they increase in sophistication as they diffuse throughout the economy; they engender extensive spillovers in the forms of externalities and technological complementarities; and their evolution and diffusion span decades (even centuries).[6] Moreover, GPTs undergo rapid price declines and performance improvements; become pervasive and an integral part of most industries, products, and functions; and enable downstream innovations in products, processes, business models, and business organization. By any of these measures, the dot-com Internet ranks well against the most transformative technological breakthroughs (and subsequent commercializations) in human history.[7]

This report documents and celebrates the 25th anniversary of the commercial Internet, providing a brief history of the .com domain; chronicling the penetration and adoption of the commercial Internet in the United States, Europe, Asia, and the developing world, covering everything from the number of Web sites and users to total value and usage of e-commerce and social media; exploring new Internet-enabled business models; examining the Internet's economic impact on consumers, businesses, and workers; assessing the Internet's benefits to society; and closing with a glimpse into future trends in the Internet economy.



Early screen shot of the Internet

The .com domain is one of six top level domains (TLDs), Internet name categories created by Internet RFC 920 in October 1984 as part of a reorganization of the Internet naming bureaucracy.[8] Since the early days of ARPANET, the task of tracking and sharing network names and addresses had been performed in a single office, originally through the Network Information Center at Stanford Research Institute (SRI NIC).[9] The creation of TLDs relieved SRI NIC of the burdensome task of ensuring that each computer on the entire Internet had a unique official name. Dividing network names into six categories enabled administration to be delegated to several agencies, each responsible for a portion of the Internet. As the RFC explained:

> Domains are administrative entities. The purpose and expected use of domains is to divide the name management required of a central administration and assign it to sub-administrations. There are no geographical, topological, or technological constraints on a domain. The hosts in a domain need not have common hardware or software, nor even common protocols. Most of the requirements and limitations on domains are designed to ensure responsible administration.[10]

A separate "sub-administration" was created for each of the domains, with each applying different policies regarding who could obtain a name, how much it cost, and how it could be used. This entire process was ultimately transferred to the Internet Corporation for Assigned Names and Numbers (ICANN), a private sector, non-profit corporation created in 1998 to assume responsibility for managing domain name systems.

A system for automatically translating computer and network names into Internet Protocol (IP) addresses (the familiar "dotted decimal" numbers such as 74.125.19.106 that serve as the Internet's equivalent of phone numbers) had already been created by RFC 882 in 1983, but it couldn't be deployed until the Internet community decided how it wanted to organize the name space and who would administer it.[11]

The decision to organize domain names into specific master domains was driven by the belief that different kinds of organizations would want to manage their portion of the overall name system differently. This intuition proved correct, as the process for registering a name under .edu is very different from that for .com, .org, .gov, or .mil. The master list reflected the membership of the Internet at the time: half of the TLDs were government entities, many were universities, two were non-profits, and then there was .com; the catch-all for the small number of for-profit entities who were allowed on the Internet because they had government research contracts.

.com, a truncation of "company" and "commercial," was almost named .cor, short for "corporate," but the first choice was discarded when it was realized that non-profits can be corporations too (another candidate, .biz, was rejected because all organizations are businesses of a sort). Jake Feinler of SRI NIC is regarded by the Internet community as the chief instigator of .com, but nothing happened in Internet administration in those days unless it was approved by the late Jon Postel, the man unofficially responsible for keeping the Internet's components consistent with each other.

Despite its prominence on today's Internet, .com was a bit of an afterthought at the time. Internet use was circumscribed by an Acceptable Use Policy (AUP) created by the U.S Department of Defense that forbade for-profit activity outside the scope of research work, there weren't any commercial Internet Service Providers, and it was difficult to get on the Internet, even for research institutions. CSNET, a network that connected university computer science departments to ARPANET through a shared connection, was the easiest path to access, but CSNET didn't accommodate for-profit organizations; its successor, NSFNET, was two years away from its deployment in 1986.

The annual global economic benefit of the commercial Internet equals $1.5 trillion, more than the global sales of medicine, investment in renewable energy, and government investment in R&D, combined.

The first .com registration, symbolics.com, was issued on March 15, 1985, to Symbolics, Inc., a now defunct vendor of artificial intelligence systems spun out of the Massachusetts Institute of Technology (MIT).[12] The domain name was acquired by XF.com and now serves as the personal blog of XF.com owner Aron Meystedt. Symbolics wasn't the kind of company thought of as a dot-com today. Its product line wasn't network-oriented, and it didn't transact business over the Internet (the AUP prohibited that sort of thing) but it had an Internet presence because of its close ties to MIT and the fact that most of its customers were academics. The "killer application" for Symbolics, as for most of the Internet, was e-mail, but the Internet connection would have simplified customer support and system maintenance as well. Other early domain name registrations went to ARPANET engineering firm BBN as well as to Carnegie Mellon University and several other universities in late April 1985.[13] Table 1 shows a list of the 100 oldest .com domain names.

Table 1: 100 oldest .com domain names

Rank	Date	Domain Name	Rank	Date	Domain Name	Rank	Date	Domain Name
1	15-Mar-85	Symbolics.com	16	8-May-86	TEK.com	30	27-Oct-86	Inmet.com
2	24-Apr-85	BBN.com	18	10-Jul-86	FMC.com	30	27-Oct-86	Kesmai.com
3	24-May-85	Think.com	18	10-Jul-86	UB.com	30	27-Oct-86	Mentor.com
4	11-Jul-85	MCC.com	20	5-Aug-86	Bell-ATL.com	30	27-Oct-86	NEC.com
5	30-Sep-85	DEC.com	20	5-Aug-86	GE.com	30	27-Oct-86	Ray.com
6	7-Nov-85	Northrop.com	20	5-Aug-86	Grebyn.com	30	27-Oct-86	Rosemount.com
7	9-Jan-86	Xerox.com	20	5-Aug-86	ISC.com	30	27-Oct-86	Vortex.com
8	17-Jan-86	SRI.com	20	5-Aug-86	NSC.com	40	5-Nov-86	Alcoa.com
9	3-Mar-86	HP.com	20	5-Aug-86	Stargate.com	40	5-Nov-86	GTE.com
10	5-Mar-86	Bellcore.com	26	2-Sep-86	Boeing.com	42	17-Nov-86	Adobe.com
11	19-Mar-86	IBM.com	27	18-Sep-86	ITCorp.com	42	17-Nov-86	AMD.com
11	19-Mar-86	Sun.com	28	29-Sep-86	Siemens.com	42	17-Nov-86	DAS.com
13	25-Mar-86	Intel.com	29	18-Oct-86	Pyramid.com	42	17-Nov-86	Data IO.com
13	25-Mar-86	TI.com	30	27-Oct-86	AlphaCDC.com	42	17-Nov-86	Octopus.com
15	25-Apr-86	ATT.com	30	27-Oct-86	BDM.com	42	17-Nov-86	Portal.com
16	8-May-86	GMR.com	30	27-Oct-86	Fluke.com	42	17-Nov-86	Teltone.com

Rank	Date	Domain Name	Rank	Date	Domain Name	Rank	Date	Domain Name
42	11-Dec-86	3Com.com	67	4-Apr-87	Philips.com	85	31-Aug-87	Quick.com
50	11-Dec-86	Amdahl.com	68	23-Apr-87	Datacube.com	86	3-Sep-87	Allied.com
50	11-Dec-86	CCUR.com	68	23-Apr-87	Kai.com	86	3-Sep-87	DSC.com
50	11-Dec-86	CI.com	68	23-Apr-87	TIC.com	86	3-Sep-87	SCO.com
50	11-Dec-86	Convergent.com	68	23-Apr-87	Vine.com	89	22-Sep-87	Gene.com
50	11-Dec-86	DG.com	72	30-Apr-87	NCR.com	89	22-Sep-87	KCCS.com
50	11-Dec-86	Peregrine.com	73	14-May-87	Cisco.com	89	22-Sep-87	Spectra.com
50	11-Dec-86	Quad.com	73	14-May-87	RDL.com	89	22-Sep-87	WLK.com
50	11-Dec-86	SQ.com	75	20-May-87	SLB.com	93	30-Sep-87	Mentat.com
50	11-Dec-86	Tandy.com	76	27-May-87	ParcPlace.com	94	14-Oct-87	WYSE.com
50	11-Dec-86	TTI.com	76	27-May-87	UTC.com	95	2-Nov-87	CFG.com
50	11-Dec-86	Unisys.com	78	26-Jun-87	IDE.com	96	9-Nov-87	Marble.com
61	19-Jan-87	CGI.com	79	9-Jul-87	TRW.com	97	16-Nov-87	Cayman.com
61	19-Jan-87	CTS.com	80	13-Jul-87	Unipress.com	97	16-Nov-87	Entity.com
61	19-Jan-87	SPDCC.com	81	27-Jul-87	Dupont.com	99	24-Nov-87	KSR.com
64	19-Feb-87	Apple.com	81	27-Jul-87	Lockheed.com	100	30-Nov-87	NynexST.com
65	4-Mar-87	NMA.com	83	28-Jul-87	Rosetta.com			
65	4-Mar-87	Prime.com	84	18-Aug-87	Toad.com			

Source: https://www.iwhois.com/oldest/[14]

The Internet is a general purpose technology, one whose significance to society should be viewed as on par with the development of inexpensive steel, the telephone, the internal combustion engine, or electricity.

Brad Templeton, chairman of the Electronic Frontier Foundation, formed the Clarinet Communications Corporation (ClariNet) in 1989, which may be the first Internet-oriented businesses:[15]

> ClariNet has a claim on being the first "dot-com." Of course, how one judges that depends on your definition of what a dot-com company is, and there are of course other definitions and other companies with valid claims.[16]

ClariNet was also the Internet's first, and for a long time largest, electronic newspaper; it distributed wire service copy to subscribers over Usenet, an unrestricted bulletin board-like system that intersected the Internet but was also independent of it, as CSNET had been. Until the creation of the Commercial Internet Exchange in 1991 and the subsequent privatization of NSFNET, ClariNet operated in what can charitably be described as a legal gray area, transacting commercial business across the Internet in defiance of the AUP. ClariNet could do this because nobody was charged with enforcing the AUP, and Internet users as a whole tended toward a live-and-let-live attitude.

While .com was a domain address that businesses could obtain, the capability to conduct real business with it was enabled by the privatization of the Internet's backbone, completed by 1998.

> The privatization of the backbone network involved reshaping the National Science Foundation Network (NSFNET) into what is known today as the Internet. This process affected both the content across the NSFNET as well as the control of the underlying infrastructure. The actual privatization consisted of government shifting from the practice of contracting out a government-subsidized backbone to allowing the market to provide backbone services.[17]

Commercial backbone services were initially provided at four Network Access Points owned by telephone companies; these have since been replaced by a worldwide network of 300 carrier-neutral Internet Exchange Points. Universities peered and purchased Internet transit services after privatization, just as commercial organizations do today.

The privatized Internet backbone was unregulated, which made commerce and investment feasible on a large scale, and the invention and consumer acceptance of the World Wide Web stimulated critical consumer interest in the evolving Internet. The first dot-coms to create significant audiences were Internet search and indexing services, such as Yahoo! and Alta Vista. One notable milestone of the early dot-com era was the deployment of the banner ad, pioneered by Hotwired.com for Zima and AT&T in October 1994.

The Internet represents not just a unified global network for voice, data, and video, but also a fundamentally new digital infrastructure platform through which global commerce can occur.

After the commercialization of the University of Illinois-created Mosaic browser as Netscape in 1995, the Internet took off. Within a few short years, the dot-com bubble of the late 1990s to early 2000s gave rise to a number of notable failures, such as pets.com (selling dog food over the Web), Boo.com (fashion), and Excite@Home (an Internet portal). But it led to almost as many successes as failures, including pioneering successes such as Google, Amazon, eBay, and iTunes. It's a rare business that doesn't have a Web presence today, and an even rarer news service, advocacy group, or even political candidate.

eToys Sock Puppet

As this report documents, the influence of the commercial Internet has been far more enduring and transformative than one might have expected after the burst of the dot-com bubble in March 2000. In the mid- to late-1990s, one could not open up a business magazine or turn on the news without hearing about the amazing New Economy and how it was going to revolutionize both the economy and society.[18] Kevin Kelly, editor of *Wired*, opined that, "The network economy will unleash opportunities on a scale never seen before on Earth."[19] Futurists Peter Schwartz and Peter Leyden wrote that "we are watching the beginnings of a global economic boom on a scale never experienced before … a period of sustained economic growth that could eventually double the world's economy every dozen years."[20] Even business leaders succumbed to the hype. General Electric CEO Jack Welch proclaimed that, "commerce in the next decade will change more than it's changed in the last hundred years."[21] Any company not embracing the Internet was, according to popular wisdom, doomed to extinction.

Yet when epochal transformation is the bar, reality is bound to disappoint. With initial financial returns from the dot-com start-ups failing to justify their lofty equity valuations, the dot-com bubble burst—marked principally by the crash of the NASDAQ Stock Market, which by 2002 had lost 60 percent of its peak value of 5,048.62 reached on March 10, 2000—and the mass euphoria of the New Economy quickly turned to gloom and doom. It became fashionable, even the norm, to believe that the New Economy was a flash in the pan, or a myth spun by an over-imaginative media. Stephen Roach, chief economist at Morgan Stanley, and one-time New Economy champion, turned viciously on it, now seeing it as a "bubble-induced excess." Indeed, piling on the Internet's failure became a way to sell books and get on the speaking circuit. Indicting the Internet's potential in a widely touted article later to become a book, Harvard Business School's Nicholas Carr wrote in 2003, "As for information technology (IT)-spurred industry transformations, most of the ones that are going to happen have likely already happened or are in the process of happening."[22] But in reality, such dismissive perspectives were as lopsided as the earlier euphoric claims, and discounted many of the changes and innovations to be wrought by the Internet that were in fact just beginning. It turns out that a brief interruption in the midst of an economic revolution is actually the norm. As technology-historian Carlota Perez describes in *Technological Revolutions and Financial Capital*, technology revolutions start with what she calls the "installation phase" when "new technologies erupt in a maturing economy and advance like a bulldozer disrupting the established fabric and articulating new industrial networks…At the beginning of that period, the revolution is a small fact and a big promise; at the end, the new paradigm is a significant force…ready to serve as a propeller of widespread growth."[23] Perez argues that the second half of these technological revolutions, the "deployment period," is when the fabric of the economy is rewoven and reshaped by the new technology system and when the technology becomes normal best practice.

The evolution of the Internet and its dot-com businesses, characterized by a boom-bust cycle followed by subsequent widespread diffusion and adoption, followed a trajectory not at all unlike the development of the telegraph, the railroad, or the automobile industries.

However, the turning point between the two phases is usually marked by a critical crossroads, often resulting in an economic downturn. This is exactly what occurred with the dot-com economy over the last 15 to 20 years. As the installation period ended in 2000, it did indeed represent a crossroads, when it became clear that some business models would thrive and others would die. However, now, during the deployment period, the Internet is well on its way to reshaping the economy and driving growth, as evidenced in part by the fact that, although the United States is just recovering from its worst recession in 60 years, productivity is approximately three times higher than in previous pre-Internet recessions.[24] In short, while the Internet revolution may not have lived up to the most extreme hype of the late-1990s in terms of its penetration into the economy and society, it has subsequently more than fulfilled its promise. And the next decade promises as much progress, if not more, than the last.

Indeed, the evolution of the Internet and its dot-com businesses, characterized by a boom-bust cycle followed by subsequent widespread diffusion and adoption, followed a trajectory not at all unlike the development of the telegraph, the railroad, or the automobile industries. Each of these transformative technological revolutions were marked by initial overshoot, as too much speculative capital flooded into the market, spawning too many entrants chasing too few opportunities, with marketplace competition subsequently sorting companies with winning strategies and business models from the losers. This process of industry restructuring and consolidation turns out to be quite common during the initial phases of new industries spawned by technological breakthroughs.

For example, in the "dot-dash" era from 1848 to 1852, the number of telegraph miles in the United States jumped from 2,000 to 23,000.[25] While the vast majority of companies that built the industry's original infrastructure had failed by 1860, the cost of transmitting data had dropped to a penny a word and the telegraph became a vital tool of American business. Between 1870 and 1890, investment in the U.S. railroad industry quadrupled and work began on four trans-continental railroads. By 1897, one-quarter of the industry was in receivership, but a sturdy new commercial infrastructure remained and the amount of rail freight shipped grew consistently and significantly until after the creation of the Interstate Highway System.[26] Britain's railway industry similarly collapsed in 1847, leading to massive bankruptcy and failures, but many more miles of rail were built in the United Kingdom from 1827 to 1847 than in the 20 years before.[27] The same story played out with the development of the U.S. automobile industry. While there were 253 auto companies in the United States in 1908, by 1920 there were just 108, and by 1929, 80 percent of cars were produced by the Big Three of Chrysler, Ford, and General Motors. Although hundreds of car companies went out of business in the 1920s, with failures just as spectacular as those witnessed during the dot-com bubble, these busts did not diminish the fact that the automobile industry was on the verge of revolutionizing America's economy and society. Rather, it was just getting started.[28]

For the latest transformative technology, three critical, inter-related factors led to the bursting of the dot-com bubble: 1) the initial technical infrastructure could not support the technology capabilities envisioned; 2) the expectations for the Internet's initial impact, as with most technological revolutions, was overestimated; and 3) as a consequence of and compounded by the first two reasons, the excessive valuations of dot-com businesses contributed to many of them collapsing under the weight of the expectations heaped upon them.

A critical reason why the take-off of the Internet and dot-com companies occurred more slowly than initially anticipated was that the underlying technical infrastructure—particularly the speed of the Internet over the "last mile" to the home, but also the number of Internet subscribers—took time to develop. Internet pioneers were trying to build revolutionary businesses at a time when most subscribers connecting to the Internet were doing so using dial-up modems with a mere speed of 28.8 to 56 Kbps, half of Americans weren't yet connected to the Internet at all, and hardly any Americans were connected to the Internet through mobile devices such as iPhones. In fact, at the start of the century, only 4.5 percent of U.S. households had broadband access.[29] In 2001, just 5 percent of the country's fiber optic capacity was being used, signifying that while sufficient back-haul Internet infrastructure had been built out, the last mile to the home had not yet been.[30] In addition, a number of Internet technologies taken for granted today, including Web browsers, media compression algorithms, low-cost storage, low-cost Web design and construction, and Flash scripting, had not yet matured to the point of being ready for mass-market use.

Because the underlying Internet infrastructure had not been sufficiently diffused or adopted, subscribers lacked technologies, especially the Internet connectivity speeds, to fully access the Web services and functionalities envisioned by the Internet pioneers. Consider the case of Boo.com, a poster child for "dot-bomb" failures. As a start-up showered with $100 million of venture capital in 1999, its goal was to sell designer clothes across 18 European countries. But since unmetered dial-up access was only then being introduced in Europe, few customers who looked at the Web site ever managed to make it as far as the checkout stage.[31] Boo.com spent $188 million in just six months in its effort to create a global online fashion store before going bankrupt in May 2000.[32] If slow Internet speeds and relatively few Internet users made it difficult for shopping sites to thrive, it made it virtually impossible for early Web players, such as Broadcast.com, who were trying to offer video and multimedia services, to succeed. As *Wired* elegantly wrote about Broadcast.com's failed business model, "Internet video before broadband was like pouring tar through a garden hose."[33]

What the failure of once dot-com luminaries such as Webvan.com, pets.com, or Broadcast.com masks is that the services those companies envisioned offering over the Internet have since come to fruition.

This led to a classic chicken-or-egg problem: Web companies (and their venture capital backers) became reticent to invest in new technologies and features knowing that consumers lacked the Internet access speeds to enjoy them; conversely, consumers and broadband providers were less inclined to demand higher Internet access speeds and invest in higher speed networks, respectively. This dynamic stunted broadband take-up and dot-com growth simultaneously. Companies asked, "Why develop a high-bandwidth intensive application like downloadable TV shows, telepresence, or telemedicine when few people would be able to access them at the needed speeds?" It was not until the mid- to late-2000s that high-speed broadband had been sufficiently developed, deployed, and adopted to support many of the business models originally envisioned a decade earlier.[34] For example, it is unlikely that YouTube's user-generated content-based business model would have succeeded in the late 1990s because Internet access speeds were too slow for users to quickly upload or download massive amounts of video content.[35] Conversely, once a video streaming service like YouTube had enough subscribers to take off, its continued growth, and the growth of hundreds of similar Web companies, spurred consumers to want to upgrade their Internet speeds, leading to a virtuous circle of higher speeds at lower prices, better content and applications, etc. Of course, the declining cost of connectivity and technology components played a critical role in enabling new business models as well: between 2000 and 2010, the cost per gigabit (GB) of streaming video fell from $193 to $0.028, hard drive storage cost per GB fell from $44.56 to $0.07, monthly Web storage per GB fell from $1,250 to $0.15, and monthly Web hosting per GB fell from $2.58 to $0.0005.[36]

Moreover, when it came to predicting the growth of the Internet, as is the case with most new technologies, pundits overestimated the initial rate of change and underestimated the amount of long-term impact. Indeed, most investors, entrepreneurs, and the public mistakenly thought the Internet was not like past innovations that took time to mature. As IT expert David Moschella has noted, "history says that the promise of IT is almost always farther off than it initially appears."[37] Most expected the economy to be transformed over night, and when it was not, the bubble burst.

In fact, the explicit expectation that the Internet would transform the economy so quickly contributed to many venture-backed start-up companies commercializing the Internet receiving extremely high valuations. For example, late-1990s start-up Web grocer Webvan.com raised $1.2 billion to sell groceries over the Internet, but within just two years burned through $1 billion in cash, saw its stock plummet from $30 to 6 cents a share, and went bankrupt in 2001.[38] Start-up InfoSpace.com reached a price of $1,305 per share in March 2000, but by April 2001 its stock had crashed to $22 a share.[39] Commerce One reached $600 a share before the dot-com bubble crashed, with the company going bankrupt in 2004. (Tellingly, Super Bowl XXXIV in January 2000 featured 17 dot-com companies that each paid over 2 million dollars for a 30-second commercial spot; by contrast, in January 2001, just three dot-coms bought advertising spots during Super Bowl XXXV.)[40]

Truck of grocery delivery dot-com Webvan

When the vision of overnight economic transformation was not realized, companies' valuations plummeted. As David Kirsch and Brent Goldfarb of the University of Maryland have argued, the bursting of the dot-com bubble was largely the result of exceedingly optimistic expectations and thus over-capitalization of many dot-com companies that ultimately led them to collapse under their own weight.[41] As they write, "In the mistaken pursuit of Get Big Fast, many good opportunities were sold to investors and the public as big opportunities. As the bubble burst, valuations were brought into line with the realistic scale of the typical online venture."[42]

Although the story of the dot-com crash was headlined by the spectacular failure of a few overly-capitalized start-ups, such as Webvan, pets.com, eToys.com, TheGlobe.com, iWon.com, Bid.com, Geocities.com, and plenty of others, Kirsch and Goldfarb found that the five-year survival rate of the approximately 50,000 companies, mostly dot-coms, that solicited venture capital to exploit the commercialization of the Internet was actually 48 percent.[43] This survival rate is higher than most pundits would have us believe and is similar to, or even higher than, that associated with the introduction of other general purpose technologies, and is certainly considerably higher than the typical survival rates for most new businesses. As Kirsch and Goldfarb argue, "Standing in stark contrast to the popular picture of the dot-com era consisting of a boom phase followed by an unprecedented bust, our findings suggest underlying continuity in the exploitation of entrepreneurial opportunities arising from the diffusion of a new general purpose technology." Examples of dot-com start-ups that may have failed to achieve their grandest visions but that survive today include Lycos, Theknot.com, Tripod, iVillage, AltaVista, and even Salon.com and The Motley Fool.[44] And of course, several start-ups—Amazon, eBay, Google, Yahoo!, Expedia, etc.—stand out as dot-coms that delivered on their promise to revolutionize their respective industries. (Indeed, the market capitalizations of eBay and Amazon are higher today than in 1999.)

The 48 percent five-year survival rate of dot-coms is higher than most would expect, is similar to or higher than that associated with the introduction of other general purpose technologies, and is certainly considerably higher than typical survival rates for most new businesses.

An excellent example of a dot-com start-up that failed to meet extremely high initial expectations but yet survives today as a going concern with a healthy business model is Brivo Systems.[45] Founded in 1999, Brivo Systems raised over $25 million in venture capital for a concept to build a smart mailbox for the digital age, the Smartbox.[46]

With an embedded modem and wireless Internet connection, the Smartbox was designed as a secure receptacle to receive residential package deliveries (especially from the anticipated boom in e-commerce) able to send an e-mail notification to owners once packages were safely delivered to the Smartbox (thus closing the chain of custody between online retailers, delivery companies, and the customer). Flush with capital, within 18 months Brivo Systems grew from four co-founders to a staff of almost 70. After online shopping failed to immediately take-off and the stock market bubble popped, the company slimmed down considerably and abandoned its business-to-consumer (B2C) approach. However, Brivo was one of the first companies in the world to figure out how to manage controlled access to remote locations via the Internet, received several patents for this and related technology, and survives today as a robust business-to-business (B2B) company with a suite of Web-hosted, enterprise-level building access control solutions for corporations, universities, and government agencies.[47]

But what even the spectacular failure of once dot-com luminaries like Webvan.com, pets.com, or Broadcast.com masks is that the services those companies envisioned offering over the Internet have indeed since come to fruition, even if delivered by competitors or other companies that crafted a more effective or sustainable business model. For example, out of a group of 72 dot-com companies that Hoovers (a business information service) identified as having failed by August 2001, by December 2003 over 60 percent of those Web companies were back in business, either as redirects to another Web site (pets.com was subsumed by petsmart.com) or as the brand name of other companies (allwall.com became art.com).[48]

Brivo Systems' Smartbox

A final factor in the dot-com stock collapse is that many investors of the era did not appreciate just how extensively and quickly existing brick-and-mortar companies would transform themselves into brick-and-click companies to compete with, and sometimes outcompete, start-up pure-plays. For instance, Webvan.com may have failed, but Peapod.com, by supermarket company Giant, offers consumers nearly identical service. Amazon succeeded, but its biggest competitor has been Walmart.com. Netbank (one of the first all-Internet banks) may have failed, but virtually all banks today offer their customers free online banking. And while start-ups such as Commerce One may have failed in their gambit to leverage the Internet to help Fortune 1000 companies streamline their procurement processes (competitor Ariba.com fared somewhat better, though its market capitalization fell from a high of $30 billion to $1 billion today), the reality is that almost all Fortune 1000 firms now use Internet procurement. In fact, the Internet has subtly transformed a number of "old economy" industries as firms co-opted it, subsuming the Internet into their business processes and value chains. As C.K. Prahalad and M.S. Krishnan write in *The New Age of Innovation*, to innovate, firms must embed the Internet in their IT architecture, and connect it to external devices and sensors such as RFID.[49] This is one reason why U.S. IT employment, while bottoming out in 2003, fully recovered by 2005, and by 2007 was 6.9 percent higher than the 2001 peak.[50]

Even when dot-coms failed they often left behind valuable assets. While much of the fiber optic cable laid in the early part of the 2000s remained unutilized for many years, the deployment of so much fiber led to a decline in data transport costs, enabling new, higher bandwidth-requiring applications and companies like YouTube to succeed. Today, all that fiber, and more, is now lit. In addition, even the outright failures in many cases led to overall economic growth. One study found that even dot-com failures can have significant economic benefits on local regions, as employees who are laid off go on to start successful firms or help existing firms become more competitive.[51]

Thus, the reality is that the Internet has indeed fulfilled its initial promise of transforming both the economy and society, thanks to a combination of both the dot-com success stories and the fact that established industries and companies have substantially integrated the Internet into their business operations. Just how large is the global Internet economy? The following section explores this question.

This section provides a comprehensive global overview of the types of Web sites on the Internet; looks at the evolution of .com domain names; identifies the leading online businesses; and then analyzes the Internet economy first on a global level, and then at a regional level, looking specifically at the Internet economy in the United States, Europe, Asia, and the developing world, including identifying the countries that lead the world in e-commerce.

TYPES OF WEB SITES

In general, commercial Web sites fall into at least one of eight possible categories: 1) search and portal, 2) storage and infrastructure, 3) information, 4) entertainment, 5) communication and social networking, 6) e-commerce, 7) brand and personal identity, and 8) crime.

First, search and portal sites like Google, Yahoo!, Live, and Baidu (the leading Chinese search engine), make up six of the top ten sites globally in terms of hits. This is not surprising since most people use search engines to find the information they are looking for.

Second, storage and infrastructure sites that provide file hosting such as Rapidshare and Hotfile, ad networks like Doubleclick and Clicksor, and content delivery networks like Akamai make up the most heavily trafficked destinations on the Internet.

Third, informational Web sites that principally host information, even if it is updated frequently, include sites such as the Internet Movie Database (imbd.com) and TV.com. A host of other sites maintain archives, most notably newspaper and magazine Web sites such as nytimes.com, CNN.com, and the Weatherchannel.com. Other informational Web sites include the tens of thousands of blog sites on which users publish information on a wide variety of topics. In Korea, for example, 32 percent of Internet users age six and over have their own blogs and have actively managed their blog within the last month (up by 1.5 percent compared with 2008).[52] Many analysts use a variety of categories to segment these sites, such as sports, health, news, etc.

While 21 million .com domain names were registered between 1985 and 2000, almost three times that amount, 57 million, were registered in the decade from 2000 to 2010, bringing the current number of global .com domain names close to 80 million.

Fourth, entertainment sites, including free and open video sharing sites such as YouTube and its Chinese equivalent Tudou, as well as commercial streaming services such as Netflix and Hulu, are popular online destinations. Entertainment sites include specialized Web sites such as NBA.com and NFL.com, as well as gaming sites like poker.com and World of Warcraft. These sites are increasingly leveraging video. For example, in December 2009, Hulu viewers watched more than 1 billion videos for a combined 5.8 billion minutes (97 million hours), up 140 percent versus a year ago.[53] This category also includes sites hosting pornography, a number of which are in the top 100 sites globally in terms of traffic.

While 50 percent of Internet users spoke English as their primary language in 2000, by 2009 only one-quarter did.

Fifth, social networking and communication sites like Facebook, LinkedIn, MySpace, and Mixi (the leading Japanese social networking site) help users stay in touch with friends and professional colleagues. Sites like Twitter and qq.com, a Chinese instant messaging site, help users easily communicate with one another. Sites like Flickr and Photobucket help users share pictures with each other and services such as Scribd and Google Docs help users share and collaborate on documents.

Sixth, sites engaged in selling products or services commercially include both "Web pure-play" (e.g. online only) companies such as Amazon, eBay, eSurance, Mint.com, and Taobou (the "eBay of China"), but also the millions of Web sites of "brick-and-click" businesses that both conduct business over the Internet and maintain a physical retail presence, such as BarnesandNoble.com or Borders.com. (The term "brick-and-mortar" throughout this report refers to businesses that were once or are still today characterized mainly by a physical retail presence. If they have an online presence, it is informational and not transactional in nature. However, today many businesses that were once brick-and-mortar only have added a transactional online presence, such as Gap.com or JCrew.com, and have become "brick-and-click" stores for purposes of this report.)

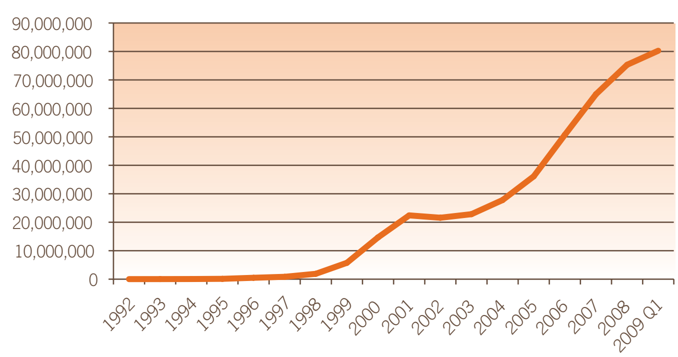
Seventh, in terms of total number of Web sites, the largest category is for the Web sites of companies that have established a presence on the Web for customer service or general brand promotion and of individuals who have established Web sites to promote individual identity on the Web. (These Web sites are thus predominantly informational and non-transactional in nature.) Businesses ranging in size from the lone consultant or neighborhood pizza shop to the world's largest company, Royal Dutch Shell, maintain Web sites to communicate with the public and support their brands. For example, the pharmaceutical firm AstraZeneca owns acidreflux.com, the greeting card company Hallmark owns easter.com, and the international food company Nestle owns icecream.com and meals.com. (The point here is that large corporations like Hallmark or Nestle actually operate multiple different Web sites; some of which to be sure are transactional in terms of selling goods or services online, but many of which are informational.) Personal Web sites and blogs play an important role in helping people find and learn more about each other. While many famous individuals have their own sites, such as Arod.com, the site for the Yankee's baseball star Alex Rodriguez, and Madonna.com, for singer Madonna, millions of not so famous "John Smith's" have their own .com domain name (although JohnSmith.com is a classified ad site).

Finally, the last category includes sites that in the old economy would be termed back alley businesses, or businesses that operate either at the edge of the law or in violation of it. These include phishing Web sites (sites that try to get a consumer to believe that they are on a legitimate site when in fact they are not) and piracy Web sites, such as Piratebay, isoHunt, and ZLM.com (the Russian movie piracy site), all of which provide access to content in violation of content owners' wishes. While many of these businesses are clearly violating the law, they continue to exist in part because the authorities in the nations they are hosted in turn a blind eye to them and in part because other nations do little to block their citizens' access to them.[54]

THE EVOLUTION OF .COM DOMAIN NAMES

Over the last 25 years, the use of .com domain names has rapidly expanded from a specialized name space for the high-tech community to an integral part of the global economy. Beginning with Symbolics.com in 1985, today there are over 80 million .com domain names and more than 200 million domain names in total.[55] Despite the collapse of the dot-com bubble, since the end of 2000 the number of registered .com domain names has increased dramatically, with 668,000 new .com domains registered, on average, every month.[56] Moreover, while 21 million .com domain names were registered between 1985 and 2000, in just the ten years since 2000, 57 million more have been registered (see figure 1).

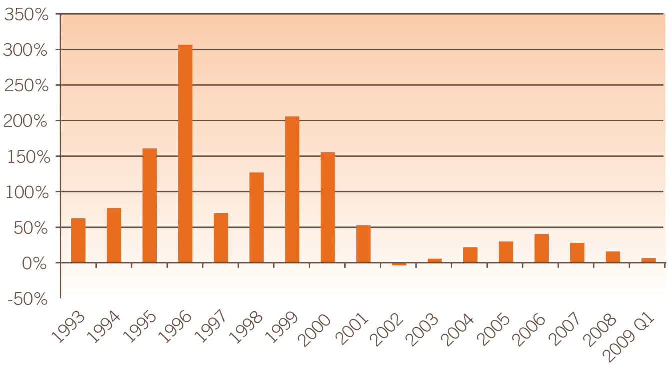
Figure 1: Growth of .com domain names globally, 1992-2009



Source: zooknic.com[57]

Although the number of .com domain names continues to increase, each year new .com registrations constitute a declining percentage of the total. But this is in part a reflection of the fact that the base of registered .com domain names had already grown so large. As figure 2 shows, annual growth in .com domain names as a percentage of all domain names peaked in 1996 with growth rates over 300 percent, yet growth continued in 2008 at a healthy 20 percent.

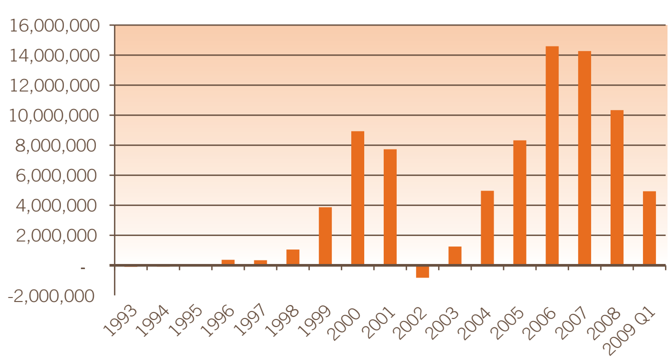
Figure 2: Growth in .com domain names as percent of .com domain names globally, 1993-2009



Sources: zooknic.com[58] and author's calculations

The global recession has done little to deter the growth of total registrations of .com domain names, with the number of registered domain names increasing every month since 2007 by 556,000 and a total of 8.2 million new .com domain names being created since the first quarter of 2008 (see figure 3). Internet traffic to .com domains has also increased throughout 2008 and 2009. According to VeriSign, the global operator for .com and .net domains, the overall query load (individually accessed Web pages) per day during the second quarter of 2009 increased by 29 percent from 38 billion to 49 billion queries, reflecting the Internet's growth and its hundreds of millions of new users worldwide.[59] Indeed, since 2004, when VeriSign first started publishing its Domain Name Industry Briefs, the per day query load has increased by 250 percent (from 14 billion in the first study).[60] Although increased Internet traffic to .coms does not necessarily mean an increase in economic activity online, given the commercial nature of many .com domains such increases likely reflect the growing importance of the Internet economy.

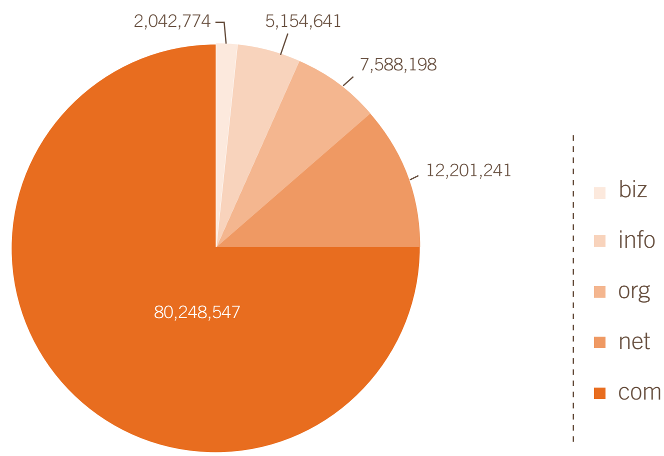
Figure 3: Annual global growth in .com domain names, 1993-2009



Sources: Zooknic.com[61] and author's calculations

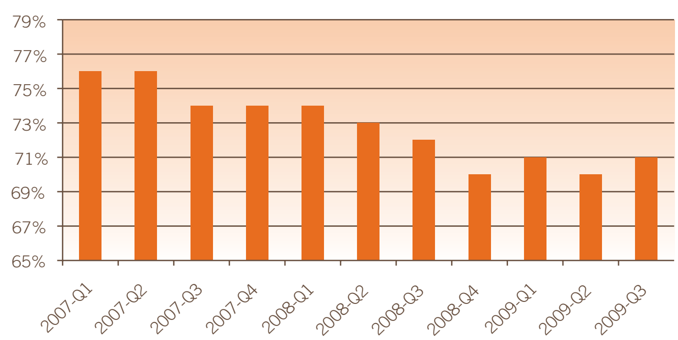
Web sites with .com domain names account for the lion's share of online content, making up the vast majority of top level domain names, the highest level of the hierarchy in the Internet Domain Naming System. As figure 4 illustrates, the .com domain accounts for over three-fourths of total TLDs. Not only does .com represent the largest share of TLDs, .com has grown faster since 2005 than any other TLD. Between 2005 and 2009, .biz, .info, and .org grew by 88, 55, and 129 percent respectively, while .com grew by 140 percent. And despite all the talk of the Internet economy being dizzyingly volatile, the persistence of most .com domain names is reasonably stable. In the first half of 2009, 70 percent of the .com domain names that were up for renewal were renewed, down only slightly from 2008 (see figure 5). Throughout the course of the Internet economy, almost 400 million .com domain names have been created with roughly a quarter of those still active.[62]

Figure 4: Total domain names by TLD, 2009



Source: VeriSign, 2009[63]

Figure 5: .Com/.Net registry renewal rates, 2007-2009



Source: VeriSign, 2009[64]

ONLINE BUSINESSES

In most developed nations today, virtually every business has at least an online presence, whether it be a brick-and-mortar (traditional business), a brick-and-click (a business that both sells online as well as at a physical location), or a pure-play (an online business with no physical counterpart) enterprise.[65]

Within the United States, the largest segments online in 2007 by number of Web site visits were search and email (23.2 percent),

Table 2: Most popular Web sites internationally by category

News	Business	Shopping	Health	Sports
news.yahoo.com	finance.yahoo.com	amazon.com	nih.gov	espn.com
bbc.co.uk	paypal.com	ebay.com	webmd.com	sports.yahoo.com
cnn.com	alibaba.com	netflix.com	health.yahoo.com	cricinfo.com
news.bbc.uk	ezinearticles.com	amazon.co.uk	focusonwomenshealth.com	nba.com
news.google.com	bankofamerica.com	walmart.com	ncbi.nlm.nih.gov	nfl.com
nytimes.com	istockphoto.com	bestbuy.com	mayoclinic.com	sportsillustrated.com
weather.com	online.wsj.com	ikea.com	walgreens.com	livescore.com
my.yahoo.com	skype.com	target.com	nlm.nih.gov	msn.foxsports.com
huffingtonpost.com	ups.com	newegg.com	drugs.com	soccernet.espn.go.com
msnbc.msn.com	constantcontact.com	stores.ebay.com	weightwatchers.com	skypesports.com

Source: www.Alexa.com[67]

entertainment (19.6 percent), commercial (15.3 percent), social networking (9.2 percent), and news and media Web sites (3.5 percent).[66] Table 2 shows the most globally-popular Web sites across five predetermined categories—news, business, shopping, health, and sports—as defined by Alexa.com, an international Web site research firm.

The most popular Web sites vary by nation. In many nations, however, the most visited Web sites are those of American firms. For example, in Albania, the top five Web sites in terms of traffic are Facebook, Google, YouTube, Yahoo!, and Windows Live, in that order.[68] In Nepal, the order switches, with Google first, then Facebook, Google Nepal, Yahoo!, and Windows Live. In Sudan, it's the same five, only in this order: Google, Facebook, Yahoo!, Windows Live, and YouTube. In Iran, Google and Yahoo! are numbers one and two, with three blog sites ranked third, fourth, and fifth: two free Iranian blogs, Blogfa.com and mihanblog.com, and a U.S. site, blogger.com, ranked fifth. However, once one gets beyond the top five to ten sites, there is considerable diversity in the top 100 sites in each nation. For example, the United States and Mexico share 39 sites that are both on the nations' top 100 sites (as measured by visitors), but the United States and China share only eight sites. And while the top 15 most popular Web sites are the same across most nations, in general, the remaining top-ranked Web sites differ from one nation to another.[69]

Amongst the 100 most popular Web sites in 2009, pure-play Web sites comprise the overwhelming majority: 94 percent of the top Web sites were pure-plays, but only 6 percent were brick-and-clicks. (See table 3 for the full list of the top 100 most popular sites.) Search, social networking, and entertainment sites account for the majority of pure-plays. Such enterprises receive billions of dollars in online advertising revenue and employ hundreds of thousands of employees. For example, in 2007, the top five search engines (Google, Yahoo!, AOL, Microsoft, and Ask.com) together employed close to 40,000 individuals and generated roughly $30 billion in revenue.[70] Yet employment figures do not fully capture the full value of non-retail pure-plays to the global economy. These firms tend to have high revenue-to-employee ratios, meaning they are able to create a disproportionate amount of value from their employees. For example, in 2007, the top five search engines generated $790,000 of revenue per employee, far exceeding the revenue per employee ratios of the average firm.

Table 3: 100 most popular Web sites, by pure play or brick-and-click, 2009

Rank	Site	Pure-play	Brick-and-click
1	google.com	x	
2	facebook.com	x	
3	youtube.com	x	
4	yahoo.com	x	
5	live.com	x	
6	wikipedia.org	x	
7	blogger.com	x	
8	baidu.com	x	
9	msn.com	x	
10	yahoo.co.jp	x	
11	qq.com	x	
12	google.co.in	x	
13	twitter.com	x	
14	myspace.com	x	
15	google.cn	x	
16	sina.com.cn		
17	google.de	x	
18	amazon.com	x	
19	wordpress.com	x	
20	microsoft.com		x
21	ebay.com	x	
22	bing.com	x	
23	taobao.com		
24	google.co.uk	x	
25	google.fr	x	
26	rapidshare.com	x	
27	163.com		
28	yandex.ru	x	
29	google.co.jp	x	
30	google.com.br	x	
31	mail.ru	x	
32	fc2.com	x	
33	flickr.com	x	
34	livejasmin.com	x	
35	vkontakte.ru		
36	google.it	x	
37	imdb.com	x	
38	craigslist.org	x	
39	google.es	x	
40	linkedin.com	x	
41	aol.com	x	
42	go.com	x	
43	bbc.co.uk		x
44	doubleclick.com	x	
45	sohu.com	x	
46	1e100.net	x	
47	photobucket.com	x	
48	orkut.com.br	x	
49	hi5.com	x	
50	pornhub.com	x	
51	google.com.mx	x	
52	conduit.com	x	
53	apple.com		x
54	bp.blogspot.com	x	
55	orkut.com	x	
56	ask.com	x	
57	kaixin001.com	x	
58	youporn.com	x	
59	youku.com	x	
60	google.ca	x	
61	megaupload.com	x	
62	espn.go.com		x
63	mediafire.com	x	
64	cnn.com		x
65	cnet.com	x	
66	about.com	x	
67	xvideos.com	x	
68	soso.com	x	
69	ebay.de	x	
70	imageshack.us	x	
71	adobe.com		x
72	google.ru	x	
73	rakuten.co.jp	x	
74	orkut.co.in	x	
75	tube8.com	x	
76	google.com.tr	x	
77	megavideo.com	x	
78	4shared.com	x	
79	uol.com.br	x	
80	google.co.id	x	
81	livejournal.com	x	
82	ameblo.jp	x	

Rank	Site	Pure-play	Brick-and-click
83	livedoor.com	x	
84	dailymotion.com	x	
85	files.wordpress.com	x	
86	tianya.cn	x	
87	redtube.com	x	
88	xhamster.com	x	
89	mixi.jp	x	
90	google.com.au	x	
91	thepiratebay.org	x	
92	tudou.com	x	
93	renren.com	x	
94	hotfile.com	x	
95	mozilla.com	x	
96	odnoklassniki.ru	x	
97	amazon.de	x	
98	weather.com		x
99	google.pl	x	
100	clicksor.com	x	

Source: Alexa[71]

According to the OECD *ICT Firm Rankings*, the leading Internet firms (firms that sell all or the overwhelming majority of their products and services online) are some of the most successful businesses of the past decade. As shown in table 4, the top ten Internet firms in the OECD's study—Amazon, Google, AOL, Yahoo!, IAC/Interactive, eBay, E*TRADE, Expedia, TD AMERITRADE, and Yahoo! Japan—together earned $58 billion and employed 100,000 individuals in 2006, with income growing 77 percent a year since 2000.[72]

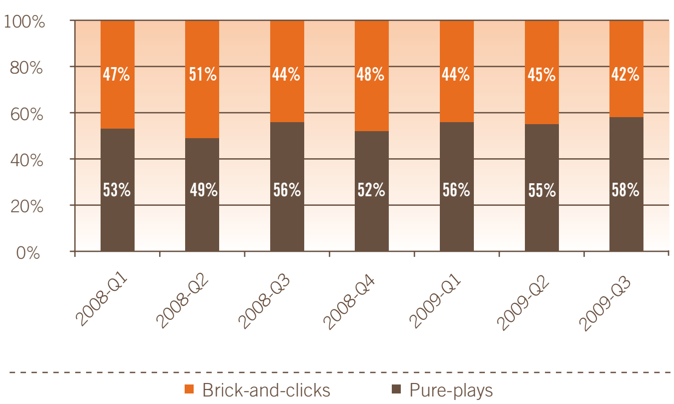
Table 4: Top 10 Internet firms

Company	Country	Revenue 2000 ($B)	Revenue 2006 ($B)	Revenue 2007 ($B)	Employees 2000	Employees 2006	R&D 2000 ($M)	R&D 2006 ($M)	Net income 2000 ($M)	Net income 2006 ($M)
Amazon	U.S.	$3,122	$10,711	$14,835	$7,500	$14,400	$269	$662	$-1,411	$190
Google	U.S.	$19	$10,605	$16,594	$1,000	$13,786	$11	$1,229	$-15	$3,077
AOL LLC	U.S.	$7,605	$7,866	$5,181	$15,000	N/A	N/A	N/A	$1,855	$1,923
Yahoo!	U.S.	$1,110	$6,426	$6,969	$3,259	$11,400	$111	$688	$71	$751
IAC/Interactive	U.S.	$2,918	$6,278	$6,373	$20,780	$26,000	N/A	N/A	$-148	$46
eBay Inc.	U.S.	$749	$5,970	$7,672	N/A	$13,200	$75	$495	$90	$1,126
E*TRADE	U.S.	$2,061	$3,840	$2,223	N/A	$4,027	N/A	N/A	N/A	$629
Expedia	U.S.	$222	$2,238	$2,665	N/A	$6,600	N/A	$121	$-78	$245
TD AMERITRADE Holding	U.S.	$516	$2,139	$2,632	N/A	$3,947	N/A	N/A	$-91	$527
Yahoo! Japan	Japan	$53	$1,493	$2,225	$196	$2,534	N/A	N/A	$1	$49
Total		**$18,375**	**$57,566**	**$67,369**	**$47,735**	**$95,894**	**$466**	**$3,195**	**$274**	**$8,563**

Source: OECD Information Technology Outlook, 2008[73]

Pure-play retail Web sites appear to have fared better in the economic downturn than brick-and-click Web sites. In Q3 2009, pure-plays represented 58 percent of the total retail value of global e-commerce, their highest share in history (see figure 6).[74] Although only 15 percent of the 100 largest U.S. companies in e-commerce retail sales were pure-plays, they represented over one-quarter of profits from the top 100 Web sites.[75] And although pure-plays represent just one-fifth of the top 20 most profitable online retail firms, they make up close to one-third of total profits.[76] Interestingly, pure-plays made up a greater number of the top 100 online retail businesses in 2001 even though they represented a smaller percentage of total revenue than in 2007. One likely reason for this is that the dot-com bust of the early 2000s helped weed out the unprofitable pure-plays that had entered the market, leaving behind leaner, more competitive firms that gained market share.

Figure 6: Percent of global online retail sales by pure-plays and brick-and-clicks



Source: comScore[77]

THE GLOBAL INTERNET ECONOMY

The United States was the first to develop the dot-com economy, in large part because the Internet was first developed here, but also because early on the United States led in Internet access (partly because in other nations consumers paid by the minute for Internet access) and because many innovative dot-com start-ups were developed in the United States. Indeed, as late as 2005, over 50 percent of the world's domain names were based in the United States, 5.5 times more than in the second place country, Germany, with 8 percent.

However, in the past decade the dot-com economy has grown significantly in other parts of the world. In many European and Asian nations (particularly Japan and Korea) the number of domain names has grown rapidly, in part because of high broadband penetration rates and in part because these nations have invested heavily in digital literacy and infrastructure. And as Internet access both from desktops and mobile devices moves from the exception to the norm, developing countries are increasingly cashing in on the value of wireless transactions. These days, developing nations are the countries experiencing the most rapid growth in new Internet users. In fact, while the top ten emerging markets had less than one-third the number of Internet users as the top ten developed markets in 2001, by 2008 emerging markets had more.[78] For example, while the United States added 9.8 million Internet users in 2007, China added 73 million.[79]

While the Internet economy is generally thought of as enterprises selling to consumers, the vast majority of e-commerce is actually comprised of businesses selling to other businesses; in 2007, roughly 90 percent of global e-commerce was B2B.

Assessing International E-commerce Leadership

Assessing which nations lead in e-commerce is not a straightforward task for two reasons. First, there is a lack of comparable and complete data between nations. Second, there is no clear agreement on which e-commerce measures should be included and at what weights. Having said that, this report identifies seven variables that appear to be the most important in assessing international e-commerce leadership: retail e-commerce as a share of GDP; percent of citizens who have purchased online; percent of firms purchasing online; percent of firms with a Web site; number of domain names per number of firms; secure servers per 100,000 inhabitants; and overall online sales and purchases as a share of total sales and purchases (B2B and B2C turnover). Data on all seven indicators were not available for all nations. Therefore, our analysis of e-commerce leaders includes nations where data on at least four indicators were available. This amounted to 30 nations (see table 5). Our analysis weighs each variable to account for the relative importance of each.[80] For example, because B2B e-commerce is much larger than B2C e-commerce, B2B variables received a higher weight.

Because nations' overall scores are sensitive to the weights assigned to the seven variables, with certain nations shifting rank based on even slight adjustments to the relative variable weights, this report provides countries' ranks in groups from 1 to 5. The four nations leading in e-commerce are Denmark, Sweden, the United Kingdom, and the United States (with an average group score of 136). The next group includes German, Norway, and Switzerland (with an average group score of 123). The third tier includes Canada, Austria, the Netherlands, Ireland, New Zealand, Australia, Japan, and Finland (with an average group score of 106). The fourth includes Korea, Luxembourg, Belgium, the Czech Republic, and France (with an average group score of 69). And the fifth group includes the Slovak Republic, Hungary, Spain, Portugal, Greece, Poland, Turkey, Italy, and Mexico (with an average group score of 6). Developing nations such as China and India, had full data been available, would likely have scored in this bottom group as well.[81]

Some of these results are not surprising, particularly the make-up of the nations in the bottom group. In most of these nations

Internet use is low. Moreover, in many nations credit card usage is limited and postal systems are not necessarily reliable. In addition, lower wages in some of these countries mean that it is sometimes cheaper for companies to have individuals do the work of taking orders and processing them than for companies to invest in the costs of computers, software, servers, and Internet access.

However, there are a number of surprises with these results. The first is that broadband leadership does not strongly correlate with leadership in e-commerce. The two leading nations in the world on broadband, Japan and Korea, score in the 3rd and 4th groups, respectively. In general, Japanese and Korean businesses have lagged behind in adopting IT in general, and e-commerce in particular. A second is that overall ICT investment is also not strongly correlated to e-commerce leadership. For example, Denmark is a world leader in e-commerce, but ranks 22nd among 40 nations in ICT investment as a share of GDP.[82] Conversely, Japan ranks third in ICT investments, but lags in e-commerce.

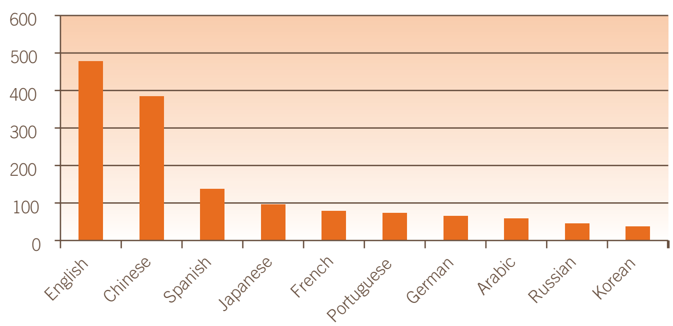
Table 5: E-commerce leadership[83]

Country	Retail as a percent of GDP	Percent of citizen who have purchased online	Percent of firms purchasing online	Domain names per firms	Percent of firms with Web sites	Secure servers per 100,000 people	E-turnover as a percent of total turnover	Grouping
Denmark	0.97%	43%	38%	5.4	84%	96	22%	1
United Kingdom	2.70%	44%	47%	4.5	75%	85	15%	1
Sweden	1.40%	39%	50%	3.3	89%	72	18%	1
United States	0.95%	34%	N/A	9.3	80%	114	16%	1
Norway	0.95%	48%	44%	4.8	72%	78	21%	2
Switzerland	0.70%	32%	57%	9.7	90%	93	9%	2
Germany	1.30%	41%	52%	6.5	78%	51	15%	2
Ireland	0.40%	26%	54%	1.7	64%	63	26%	3
Canada	0.97%	30%	65%	1.6	70%	87	N/A	3
New Zealand	N/A	31%	66%	1.3	59%	91	N/A	3
The Netherlands	0.97%	43%	40%	3.5	80%	97	12%	3
Iceland	N/A	32%	35%	1.3	77%	155	10%	3
Australia	N/A	42%	54%	4.0	55%	90	12%	3
Japan	1.30%	52%	36%	1.0	84%	44	14%	3
Austria	1.00%	26%	34%	12.6	78%	45	11%	3
Finland	N/A	32%	19%	3.3	81%	63	18%	3
Korea	0.84%	44%	43%	N/A	58%	10	15%	4
Luxembourg	N/A	37%	23%	2.9	63%	85	N/A	4
Belgium	1.30%	15%	34%	2.9	72%	23	10%	4
Czech Republic	N/A	8%	26%	N/A	71%	13	15%	4
France	1.00%	26%	18%	2.3	57%	16	13%	4
Slovak Republic	N/A	10%	9%	1.3	70%	5	11%	5
Hungary	N/A	7%	7%	1.5	47%	7	14%	5
Portugal	0.30%	6%	20%	0.9	42%	10	12%	5
Spain	0.40%	13%	19%	0.9	45%	16	9%	5
Greece	0.10%	5%	9%	8.0	60%	6	2%	5
Poland	N/A	11%	11%	1.8	53%	7	7%	5
Turkey	N/A	1%	0%	1.3	46%	5	N/A	5
Italy	0.40%	7%	12%	4.0	57%	9	2%	5
Mexico	N/A	4%	2%	0.1	N/A	1	N/A	5

Languages on the Internet

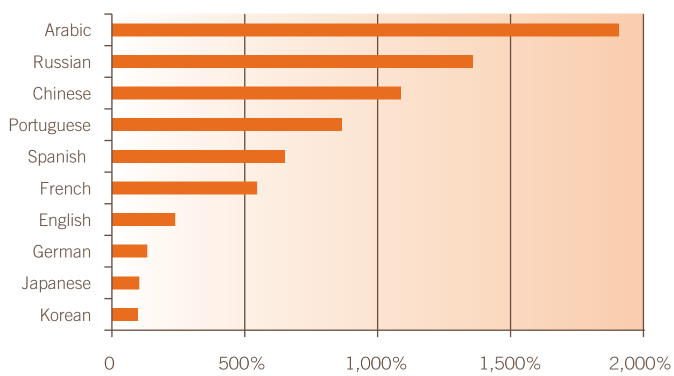
While over 50 percent of Internet users spoke English as their primary language in 2000, by 2009 only one-quarter did, with Chinese users quickly catching up, and accounting for 22 percent of users (see figure 7).[84] Indeed, while the number of English-speaking Internet users increased by 237 percent from 2000 to 2009, the number of Chinese-speaking Internet users increased by over 1,000 percent over that timeframe (see figure 8).

Figure 7: Millions of Internet users by primary language, 2009



Source: www.Internetworldstats.com[85]

Figure 8: Growth in Internet use of select languages, 2000-2009



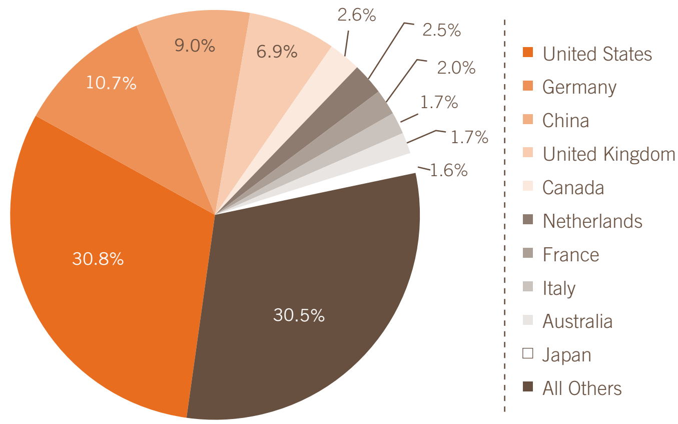
Source: www.Internetworldstats.com[86]

Domain Names

By 2009, only about one-third of the 182 million domain names worldwide were registered in the United States.[87] That being said, the United States is still by far the largest source of domain names, with a greater number of domain names than the second through sixth place countries combined.

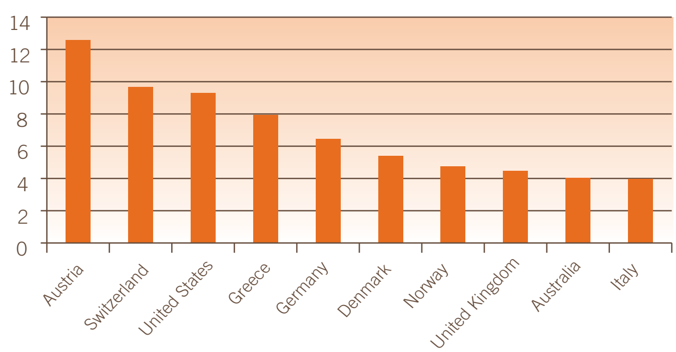
Internet domain names are still heavily concentrated in a few nations. In 2009, the top ten nations, the United States, Germany, China, the United Kingdom, the Netherlands, Canada, France, Australia, Italy, and Japan, accounted for close to 70 percent of total domain names (see figure 9) despite the fact that these nations account for just 30 percent of the global population.[88] (See Appendix A for the percentage allocation of domain names by OECD countries.) However, a more accurate measure of the intensity of a country's dot-com activity is to measure the total number of domain names within a nation compared to its total number of firms. As figure 10 shows, when comparing the ratio of domain names to total enterprises, the United States now ranks third behind Austria and Switzerland.

Figure 9: Top ten countries accounting for largest share of Internet domain names, 2008



Source: OECD[89]

Figure 10: Top ten countries by ratio of Internet domain names to firms, 2008



Source: OECD, the World Bank[90]

Despite the concentration of domain names within several countries, the dot-com economy is becoming more global. While 70 percent of domain names are located in the top ten countries, 42 million are located elsewhere, more than double the number in 2005. Furthermore, many U.S.-based dot-com firms have strong customer bases abroad. For example, Google, Amazon, Symantec, and Yahoo! earn 48, 45, 47, and 42 percent, respectively, of their revenues outside the United States, for a total of $20 billion in 2007.[91] Indeed, for several U.S. dot-coms, the majority of their users are non-Americans. Eighty-nine percent of Google's page views come from outside the United States and Microsoft and Yahoo! respectively get 75 and 67 percent of their hits from abroad.[92]

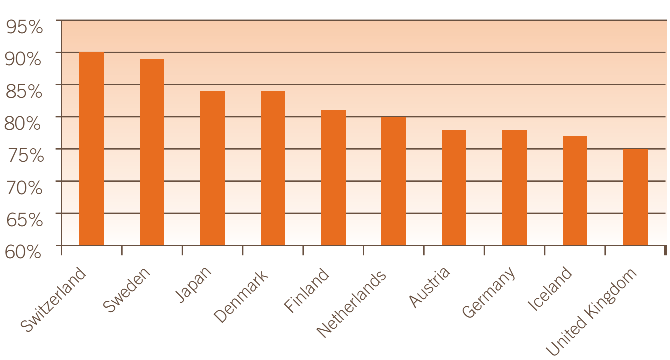
Hosts per Domain Name

An Internet host is a device connected to the Internet with a unique IP address. Internet hosts provide services such as Web, e-mail, or file transfer protocol (FTP) and as such are a good indicator of the growth of the Internet economy. As a greater number of people access the Internet, the number of hosts needed to provide a stable level of service increases. According to the OECD, over the last decade, the number of Internet hosts has increased rapidly, from less than 30 million to over 540 million, or 1,700 percent (33 percent annually). However, not all hosts use a .com domain name; the majority of hosts are found in the .net domain, which is more common for network operators. In 2008, there were 95 million hosts with a .com domain name, up from only 8 million in 1998, and 190 million with .net domains, compared to just 5 million in 1998.[93] As computing power increases, a single device may act like several by having multiple IP addresses and domain names. Coupled with the fact that Internet host surveys often miss a sizeable portion of private hosts that reside behind firewalls, this means that host counts tend to under-represent the minimum size of the Internet.[94]

Firms with Web sites

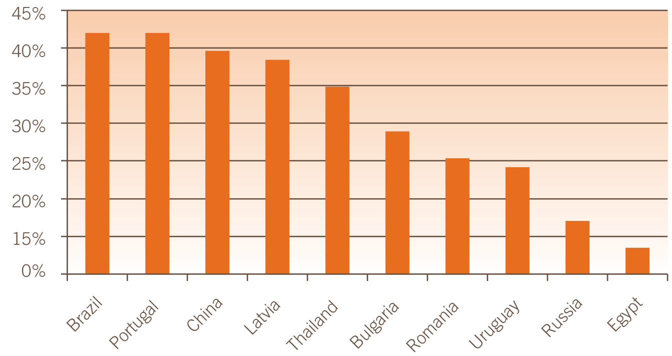
Having an Internet presence has become an essential part of modern business as the lines between shopping, browsing, working, and playing on the Web begin to blur for most consumers. In this sense, Web sites not only allow firms to get into the e-commerce game but also serve as a vital part of their advertising. In 2008, over 50 percent of shoppers said they first went online to research the products they wanted to buy. According to data from the United Nations Conference on Trade and Development (UNCTAD), in 2008, Switzerland, Sweden, and Japan led the world with 90, 89, and 84 percent of firms, respectively, having a Web site. (Figure 11 lists the top ten countries in which businesses operate a Web site as a percentage of all businesses in the country.) On the other end of the spectrum, in reverse order, Egypt, Russia, and Uruguay had the lowest levels with 18, 21, and 27 percent of firms online (see figure 12). Separately, research has shown that the Web sites of U.S. businesses tend to be the most global in scope, with those of European businesses next, and the Web sites of Asian-Pacific businesses lagging behind in this regard.[95]

Figure 11: Top ten countries by percentage of businesses with a Web site, 2007



Source: UNCTAD, Information Economy Report 2009

Figure 12: Bottom ten countries studied by percentage of businesses with a Web site, 2007

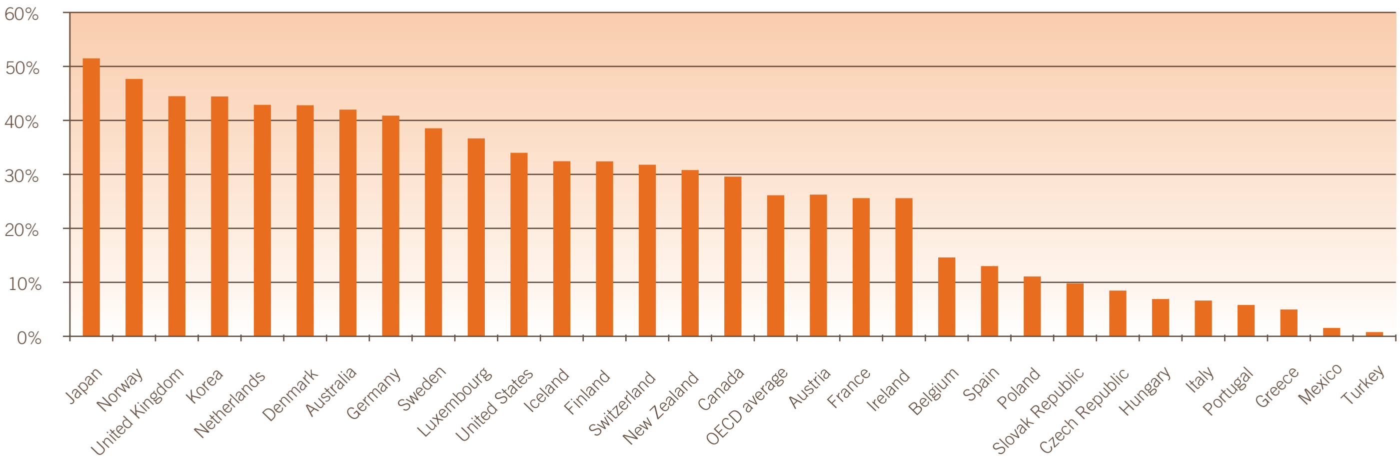


Source: UNCTAD, Information Economy Report 2009

B2C E-commerce

Given the emergence of e-commerce in the United States and the continued dominance of firms such as Amazon and eBay, it would be logical to expect that the United States leads the world in B2C e-commerce (e.g., online retail). However, using the measure of the percentage of the adult population purchasing goods or services over the Internet in the past 12 months, the United States in fact ranked eleventh among the 30 OECD nations at 34 percent in 2007. Japan leads the world with 52 percent of adults having purchased goods or services over the Internet in the past 12 months (although this figure includes everything from purchasing a $3,000 TV to a $2 ring tone for a cell phone). Following Japan are Norway, the United Kingdom, and Korea with 48, 45, and 44 percent respectively (see figure 13). The lead Japan, Norway, and Korea have in the use of B2C e-commerce comes as no surprise given that these countries have some of the world's most advanced broadband infrastructure, highest broadband penetration rates, and decidedly digitally literate populations. Although the United Kingdom has lower broadband rates than Japan, Norway, and Korea, consumers in the United Kingdom have embraced online shopping. In the United Kingdom, ten percent of non-financial sector sales were over the Internet in 2008[96] and the number of individuals banking online in the United Kingdom grew by over 500 percent, from 3.5 million to 21 million citizens, between 2000 and 2007.[97]

Figure 13: Percentage of adult population purchasing goods or services over the Internet, 2007



Source: OECD, 2008[98]

Online retail spending, per GDP, is highest in the United Kingdom, with B2C e-commerce in 2009 reaching 2.7 percent of GDP—more than double the amount in the United States. Part of this large difference may be due to differing definitions of retail between countries. Regardless, digital commerce in the United Kingdom has grown quickly between 2005 and 2009 and has become extremely popular. Despite having the highest percentage of citizens who purchase goods and services through dot-coms, B2C e-commerce as a percent of total retail sales is lower in Japan than in several other leading nations. In 2008, e-commerce in Japan reached $67 billion, or 1.3 percent of GDP, less than that in the United Kingdom, Sweden, and Germany. Part of the reason for this is the types of products Japanese purchase online. While in the United Kingdom online consumers are likely to purchase more expensive items such as computers and high-end clothing, Japanese consumers are more likely to buy cheaper digital goods such as mobile applications, music, or ringtones for their cell phones.

The four nations leding the world in e-commerce are Denmark, Sweden, the United Kingdom, and the United States.

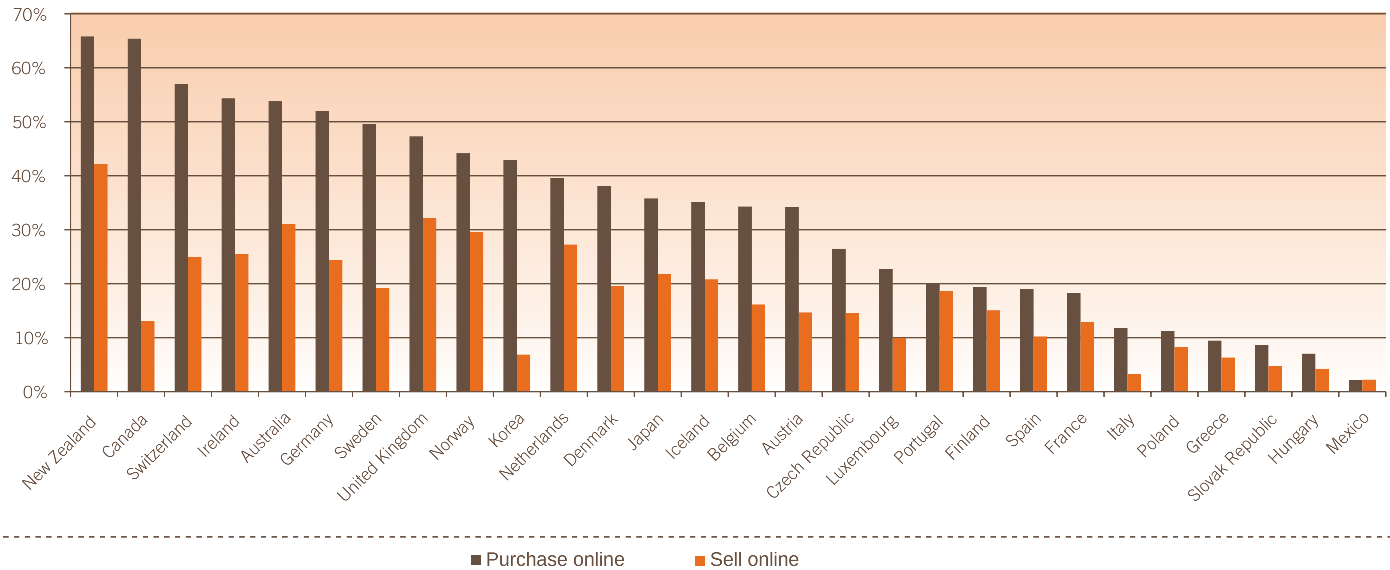
B2C e-commerce in Europe grew by 37 percent from 2006 to 2007 to reach $197 billion, or 1.3 percent of European GDP, and is expected to reach $407 billion by 2011.[99] B2C e-commerce exists to differing degrees across Europe. For example, although the United Kingdom, Germany, and France account for less than 60 percent of European Union GDP, they make up 72 percent of European B2C e-commerce (which accounts for 0.9 percent of EU GDP). In the United Kingdom, consumers spend on average $2,200 per year on e-commerce, compared to $990 in Germany, $850 in France, and $1,100 in the United States.[100]

Amongst OECD countries, Turkey, Mexico, and Greece have the lowest rates of B2C e-commerce activity, with 0.8, 1.6, and 5 percent of adults, respectively, purchasing goods over the Internet in 2007. These countries tend to have both lower levels of Internet access and citizens who both rely heavily on conventional consumer networks and who are traditionally cautious about purchasing goods and services without face-to-face contact.

B2B E-commerce

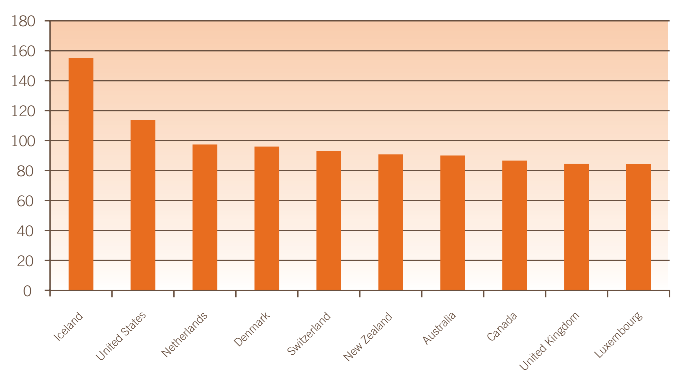
While the Internet economy is generally thought of as enterprises selling to consumers, the vast majority of e-commerce is actually comprised of businesses selling to other businesses. In 2007, roughly 90 percent of global e-commerce was B2B, slightly lower than the percentage in the United States. On average within OECD countries, 17 percent of businesses sell and 33 percent of businesses purchase over the Internet.[101] New Zealand, Canada, and Switzerland lead in the number of businesses purchasing over the Internet, with 66, 65, and 57 percent of firms, respectively, purchasing online in 2008 (see figure 14). While in most countries the amount of B2B e-commerce varies significantly by sector, in Canada, of the sectors studied, only the transportation sector had less than 50 percent of businesses purchasing online, demonstrating Canada's strength in e-commerce across the board. Appendix B provides data for 27 OECD countries showing the percentage of businesses purchasing and selling over the Internet in 2006 by the following industry sectors: construction, manufacturing, real estate, transportation and storage, wholesale trade, and retail trade.

Figure 14: Percent of firms selling and purchasing online, 27 OECD countries, 2009



Source: OECD, 2009[102]

Figure 15: Secure servers per 100,000 inhabitants, 2008



Source: OECD, 2009[104]

Security of E-Commerce

Trust is essential for countries to realize a healthy dot-com economy. While consumers are accustomed to buying goods and services through face-to-face transactions, and businesses are accustomed to making payments through closed financial networks, moving commerce to the open platform of the Internet requires maintaining the highest levels of trust and security. As commerce has grown on the Internet, identity theft and online fraud have followed. Accordingly, Internet security has become an essential part of the digital economy. One critical security measure is to use secure socket layer (SSL) certificates to encrypt traffic between Web sites and consumers so that credit cards, passwords, and other sensitive data do not travel in plain text over the Internet. The United States has the largest number of servers using SSL certificates in the world, just under 350,000. The United States, United Kingdom, and Switzerland have the largest shares of servers using SSL certificates in the world. (See Appendix C for a table showing the number of secure servers using SSL certificates and percentage growth in secure server usage from 1998 to 2008 for all OECD nations.)[103] Figure 15 shows the top ten countries for servers using SSL certificates per 100,000 inhabitants in 2008. However, since 1998, Korea, Japan, the Netherlands, Denmark, and Poland have all seen increases of over 10,000 percent in the number of servers using SSL certificates. When taken as a percent of GDP, Iceland leads the world in number of servers using SSL certificates.

.com Domain Names in the United States

With just over 63 million active .com domain names in 2009, the United States far exceeds other nations in the number of .com addresses. The United States has experienced rapid growth in registered .com domain names over the past decade. Between 1999 and 2007, the number of registered .com domain names in the United States increased by 1,300 percent. In 1999, there were roughly the same number of firms in the United States as .com domain names, however by 2007 that figure had expanded to 9 .com domain names for every one enterprise.[105] While certainly some share of .com domain names are for personal blogs or other not-for-profit sites, the speed at which the number of .com domain names has grown clearly indicates they are a vital, if not the sole, storefront for many 21st century businesses.

In the United Kingdom, consumers spend on average $2,200 per year on e-commerce, compared to $990 in Germany, $850 in France, and $1,000 in the United States.

For small firms, having an Internet presence has today become as much a requirement of doing business as having office computing systems and productivity software was 20 years ago. In 1999, only ten percent of U.S. small businesses operated a Web site (compared to almost 60 percent of large firms). In 2008, roughly 50 percent of small businesses had a Web site and virtually all large firms did.[106] In most cases, the Web site at least allows potential customers to get basic information about the business (its location, hours, personnel, etc.). Moreover, while many small businesses may not have their own Web site, they still maintain an online presence through another Web site, such as a listing of local restaurants or a social networking site.

The geographic distribution of the dot-com economy across the United States is quite varied. Forty-four percent of .com domain names in the United States are registered to addresses in just five states, California, New York, Florida, Texas, and Illinois, which collectively are home to less than one-third of the U.S. population.[107] However, Nevada, Virginia, Arizona, Utah, and Washington lead the nation in the number of .com domain names as a share of total enterprises (see table 6). The number of domain names per firm varies significantly by state across the country. Nevada has 6.5 times as many domain names per firm as does the lowest ranking state, South Dakota. (The former's particularly high score is likely attributable to the large number of gambling and adult industry sites located there, as firms in these industries may register a disproportionate number of domain names.) Nevertheless, as one would expect, states with a strong presence of high-tech companies tend to rank near the top in terms of domain name per firm, and in fact, Virginia, Utah, Washington, and California claim four of the top six spots. Also, as expected, there is a reasonably strong correlation (.53) between states with a high number of domain names per firm and states with more extensive broadband deployment.[108] Yet between 2004 and 2007 the median number of domain names in states nearly doubled from 242,000 to 400,334, suggesting that all states are playing a robust role in the dot-com economy. (See Appendix D for the total number of domain names, and number of domain names per firm, in each U.S. state.) Table 7 shows the states with the greatest growth in domain names per firm between 2002 and 2008.

Table 6: Top five states by domain names per firm

The Top Five		Domain names per firm
1	Nevada	12.3
2	Virginia	11.1
3	Arizona	8.8
4	Utah	8.5
5	Washington	7.4
U.S. Average		5.1

Source: 2008 State New Economy Index[109]

Table 7: Top seven state movers by domain names per firm

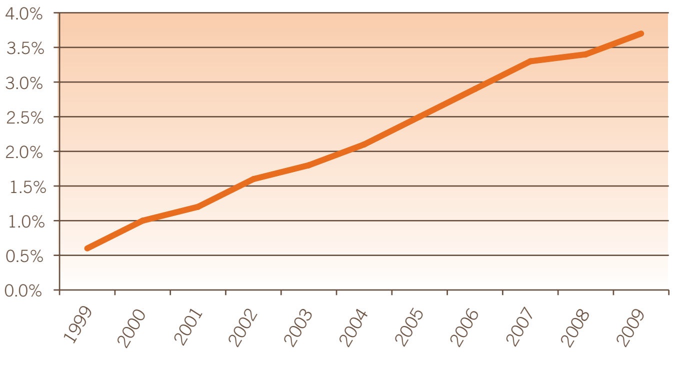
The Top Seven Movers		2002 Rank	2008 Rank	Change 2002-2008
1	Tennessee	30	19	↑11
2	Texas	20	10	↑10
3	Washington	15	5	↑10
4	Vermont	25	16	↑9
5	South Carolina	39	32	↑7
5	Utah	11	4	↑7
5	Oregon	19	12	↑7

Source: 2008 State New Economy Index[110]

E-commerce in the United States

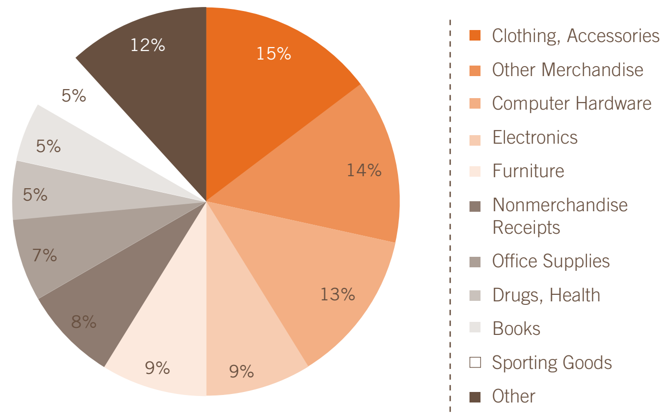
Despite popular belief around the time of the dot-com bubble's bust, there was in fact no bubble for B2C e-commerce (that is, online retail sales) in the United States. Seasonally adjusted online retail sales as a share of total retail sales have actually climbed every quarter since 1999 (see figure 16).[111] In fact, online retail sales have increased as a share of total retail sales on average by 5 percent each quarter since 1999. Moreover, between 2002 and 2007, U.S. retail sales through e-commerce increased by 23.1 percent annually in comparison to just 5 percent for total retail sales. Total U.S. B2C e-commerce reached $127 billion in 2007 and $135 billion in 2009.[112]

Figure 16: E-commerce as a percentage of total U.S. retail sales, 1999-2009



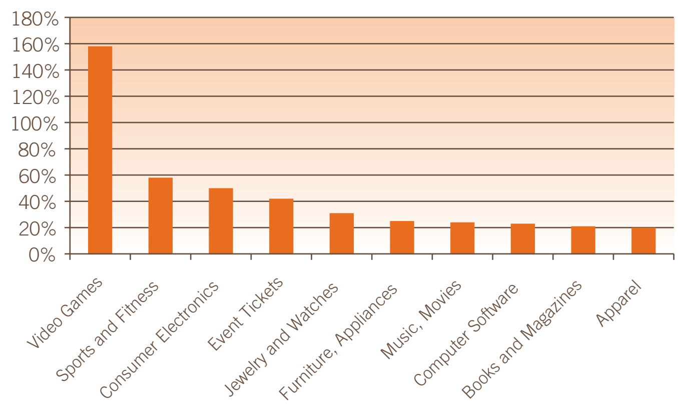
Source: U.S. Census Bureau, Annual Retail Trade Survey, 2009[113]

Figure 17: Percentage of e-commerce sales in U.S. by industry category, 2007



Source: U.S. Census Bureau, 2009[115]

Figure 18: Fastest growing e-commerce categories in U.S., 2007



Source: Digital Factbook, 2008[116]

And despite pessimistic e-commerce forecasts based on the recent economic climate, online retail continued to grow as a percentage of total retail sales between the first quarter of 2008 and the fourth quarter of 2009, reaching $39 billion in the fourth quarter of 2009. Moreover, even as total retail sales fell by 9 percent during the recession, e-commerce sales grew by 5.5 percent, or $1.9 billion (although lower than the 18.4 percent growth rate seen between 2006 and 2007). This is not to say that online retail sales have been unaffected by the recession. In Q1 and Q2 2009, the unadjusted absolute value of online retail sales dipped below Q1 and Q2 2008 levels before rebounding in Q3 2009. The 2009 holiday season, however, proved to be an unexpected boon for online retailers, as online holiday spending increased by 4 percent over 2008.[114] In fact, despite the poor overall economy, December 2009 produced the largest monthly online retail sales volume in the history of U.S. e-commerce.

With regard to U.S. B2C e-commerce, online retail sales of clothing, footwear, and accessories comprise the largest share, followed by other merchandise, computer hardware, and electronics and appliances, making up 15, 14, 13 and 9 percent, respectively (see figure 17). However, the fastest growing category for online retail is video game consoles and accessories, which grew by 159 percent between 2006 and 2007, followed by sports and fitness, consumer electronics, and event tickets with 58, 51, and 44 percent growth, respectively (see figure 18).

As Americans go online in ever greater numbers, especially via increasingly higher-speed broadband networks, and as they continue to gain comfort and familiarity with buying online, online retail sales will likely continue to grow at a more rapid rate than overall retail sales for the foreseeable future.[117] This growth is aided as online retailers increasingly offer free shipping and frequently do a better job of marketing (including sales offers emailed directly to consumers) than offline businesses.[118] Moreover, online retailers continue to develop techniques to improve their Web sites by including, for example, more detailed product descriptions, images, and user reviews. As a result, according to the American Customer Satisfaction Index, consumers are more satisfied with online retail than offline retail. In a 2006 survey, online retailers scored an average of 9 percent higher than general retailers, up from 5 percent higher than in 2000.[119]

American consumers are more satisfied with online than offline retail; in a 2006 survey, online retailers scored an average of 9 percent higher than general retailers, up from 5 percent higher than in 2000.

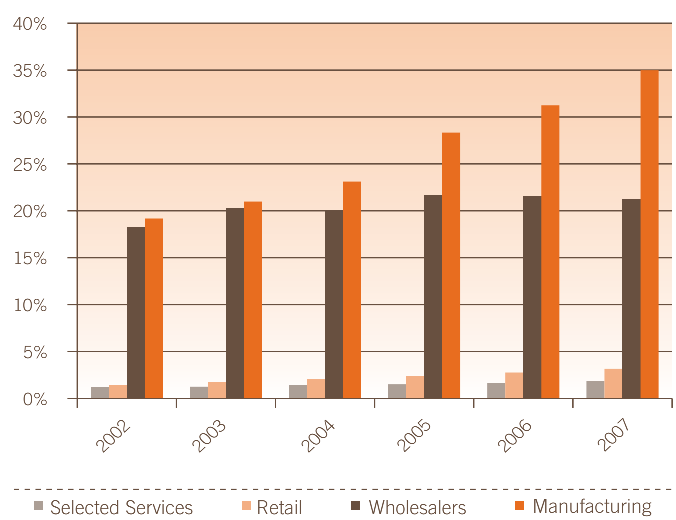
Notwithstanding this growth, online retail sales still account for a modest share of overall retail sales, just over 3.5 percent of total revenue in 2009. Considering that three-quarters of adult Americans use the Internet, over 80 percent of whom have broadband access at home, online retail sales seem low.[120] Some products are still hard to buy over the Internet (such as furniture or large appliances, where shipping costs are usually very high and customers often wish to visually inspect the item before purchase). Other products and services are hard to buy over the Internet due to state regulations or resistance from wholesale or retail middlemen. For example, many states impose restrictions on wine and beer purchases over the Internet, and all 50 U.S. states prohibit the sale of vehicles over the Internet direct from automobile manufacturers. And yet while the percentage of Americans using B2C e-commerce falls below countries such as Korea, Japan, Norway, and the United Kingdom, U.S. spending on Internet purchases is still nearly 2.5 times the OECD average.

Manufacturing and Wholesale Trade: Despite the rapid growth of online retail sales, e-commerce is actually much more prominent in other major sectors of the economy, especially in manufacturing and merchant wholesale trade. This is because B2B e-commerce is actually much larger than B2C e-commerce activity, both in the United States and around the world. Indeed, B2B e-commerce within the manufacturing sector has played a major role in bringing down expenditures by reducing transaction costs, creating more flexible supply chains, and enabling manufacturers to rely less on inventory. In 2007, combined B2C and B2B e-commerce within the manufacturing sector reached $1.8 billion, or 35 percent of total trade, up from 18 percent in 2002 (see figure 19).[121] (See Appendix E for underlying data showing the dollar and percentage amounts that B2B e-commerce accounted for in terms of the total amount of commercial trade in the manufacturing, wholesale trade, retail trade, and selected services sectors from 2002 to 2007.)

B2B e-commerce is pervasive within the manufacturing sector, accounting for at least 17 percent of total shipments in 21 manufacturing industries studied by the U.S. Census.[122] Within the U.S. manufacturing sector, the beverage and tobacco, transportation equipment, and textile industries account for the largest shares of B2B e-commerce as a percent of total trade, at 56, 56, and 47 percent, respectively. (See Appendix F for a table showing the dollar value and percentage of sales that B2B e-commerce activity accounts for across 21 manufacturing industries in the United States.)

Services: Despite only making up 2 percent of total services revenue, online services have grown steadily. They are particularly important in services that are information-rich in nature and do not require person-to-person interaction. While people increasingly use the Internet to schedule a haircut, for example, getting your haircut still requires physical proximity to the barber. Two informational services that have a fairly large online market share are travel and banking. Online reservations account for one-quarter of the reservation and travel industry's revenue.[123] In total, 63.1 million U.S. households (about 57 percent) used Internet banking as of August 2008.[124] However, online banking in the United States varies considerably by income level. Currently 69 percent of higher-income Americans (those earning more than $100,000 a year) use online banking, but only 19 percent of American households earning under $50,000 do so. Many believe that mobile devices present an opportunity to expand the reach of online banking. The number of mobile banking customers in the United States is anticipated to increase by 2,000 percent between 2006 and the end of 2010, and given the relative price of mobile devices to PCs it is reasonable to assume a greater number of these new customers will be from lower-income consumers.[125]

Figure 19: E-commerce as a percent of total trade value, in U.S., 2002-2007



Source: U.S. Census Bureau, 2009[126]

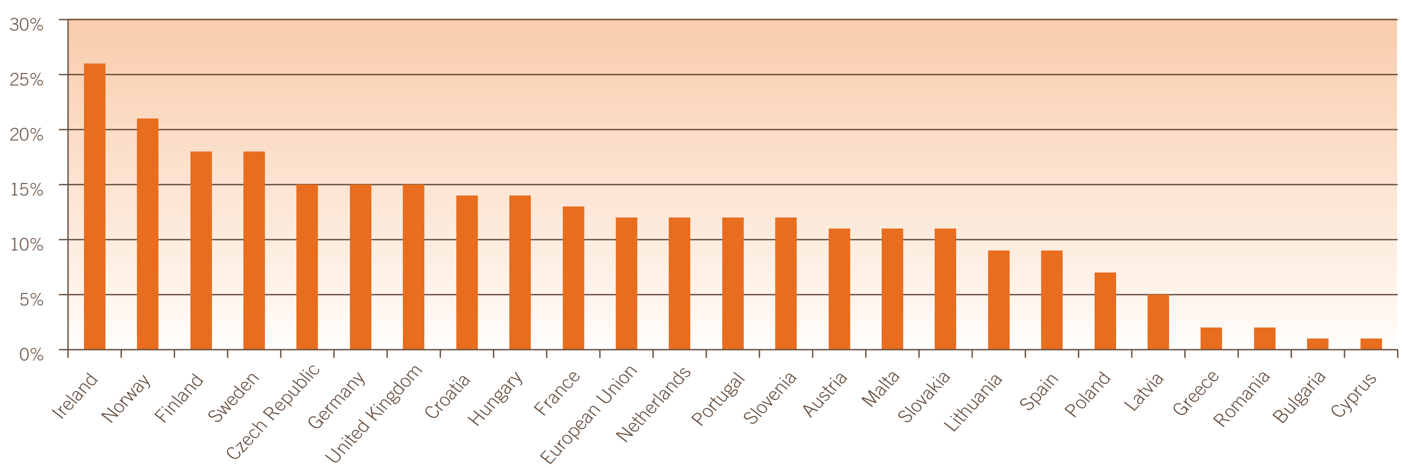
THE EUROPEAN INTERNET ECONOMY

Although behind the United States, the Internet economy throughout Europe is highly developed, particularly in Northern and Western Europe. Over one-third of Europeans purchased goods or services online in 2009, a percentage that is estimated to grow to over half by 2013. Yet there is significant diversity within EU27 nations.[127] In Norway, the United Kingdom, Denmark, Sweden, and the Netherlands, over 60 percent of the adult population purchased goods or services over the Internet in 2009, compared to less than 10 percent in many small Eastern European nations. Although much of this discrepancy can be attributed to poor digital infrastructure, cultural factors such as trust levels in e-commerce and attitudes towards distance shopping hinder the dot-com economy in some countries.[128] Overall, the percentage of dot-com shoppers grew by 85 percent in Europe between 2004 and 2009. Although emerging markets in Eastern Europe saw the largest percentage growth, even countries with established Internet markets, such as Germany, Denmark, Finland, Norway, and the United Kingdom grew by over 50 percent.

As figure 20 shows, Ireland along with several Nordic nations lead Europe in percent of enterprise sales and procurement through e-commerce (both B2B and B2C), with Eastern and Southern Europe lagging. The discrepancies within Europe in the dot-com economy are not surprising given Northern Europe's clear lead in digital infrastructure, from some of the highest broadband speeds and penetration rates in the world to a highly digitally-literate population. Southern and Eastern European nations on the whole have seen slower economic growth and slower deployment of digital infrastructure, and in turn have traditionally had lower levels of digital transactions. However, some Eastern European countries such as Estonia have made significant investments in digital infrastructure and education and consequently have been able to take advantage of the dot-com economy. For example, as early as 2004, East Uhispank, Estonia's second largest bank, reported that more than half its customers bank online.[129] Ireland's impressive leadership in e-commerce is mostly attributable to high levels of B2B transactions in its industrial and manufacturing sectors. Of the 27 countries assessed in one study, Ireland's manufacturing sector came in second in the world behind only New Zealand in the percentage of firms that sold or procured online, with 24 percent of firms selling and 54 percent of firms purchasing through e-commerce.[130]

In terms of progress, the fastest growing European nation since 2003 in the growth of e-commerce as a share of total sales is Portugal, which experienced 650 percent growth. Part of Portugal's fast percentage growth rate reflects its low initial starting point. But some of the country's progress appears linked directly to policy. In the last half decade, Portugal has gone to great lengths to digitize its economy and often gets credit for being one of the countries that has seen the most progress in deploying digital infrastructure. In 2009, Portugal was ranked as the number one country in the world in terms of ease of starting a new business thanks to Portugal's new e-government business registration portal, Simplex. The Simplex system has completely digitized the process of registering new businesses in Portugal (the "paperwork" can be completed in just 20 minutes online), and doing so may have created the incentive structure needed to convince businesses in Portugal to begin taking advantage of B2B e-commerce. Spain and Norway also saw rapid improvements, of about 330 and 240 percent, respectively, in percent of enterprise sales through e-commerce (see table 8). Norway's growth is particularly impressive; it was already a leader in 2003, and by 2009 placed second (out of those countries for which data are available) behind Ireland in percent of enterprise sales through e-commerce.

Figure 20: Percent of enterprise sales through e-commerce, select EU countries, 2009



Source: Eurostat, 2009[131]

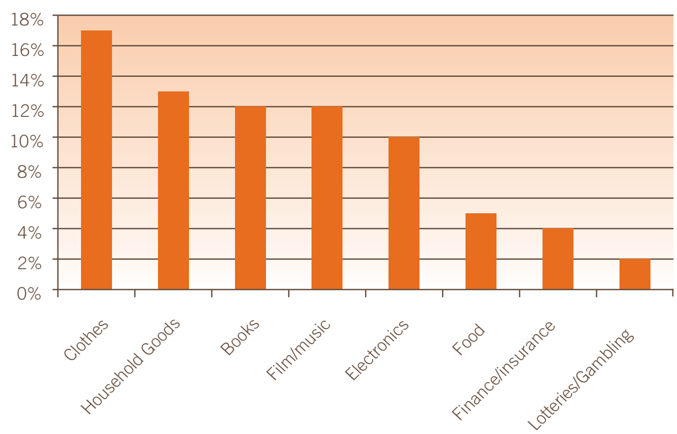
Table 8: E-commerce as a share of total sales, selected European countries

Country	E-commerce as a share of total turnover, 2003	E-commerce as a share of total turnover, 2004	E-commerce as a share of total turnover, 2005	E-commerce as a share of total turnover, 2006	E-commerce as a share of total turnover, 2009	Percent Change in e-commerce 2003-2009
Portugal	1.6	4.9	N/A	8.2	12	+650%
Spain	2.1	2.9	2.7	6.9	9	+329%
Norway	6.2	7.5	14.7	13.9	21	+239%
Czech Republic	5.7	5.9	8.4	7.1	15	+163%
Poland	N/A	2.8	4.4	5.9	7	+150%
Denmark	7.5	12.2	N/A	17.5	N/A	+133%
Greece	0.9	1.6	2.1	2.8	2	+122%
Austria	6.3	6.8	7	9.9	11	+75%
Finland	10.6	12.7	14.2	14.3	18	+70%
Ireland	16.6	18.3	20.2	16.7	26	+57%
Sweden	12.3	N/A	N/A	13.6	18	+46%
Germany	N/A	11.3	13	13.9	15	+33%
United Kingdom	11.9	14.3	15.6	17.4	15	+26%
Belgium	7	6.5	8.8	7.9	N/A	+13%
Iceland	5.9	N/A	N/A	8	N/A	+36%
Italy	1.9	3.4	2.1	2	N/A	+5%

Source: E-Stats, 2009[132]

The distribution of online retail sales throughout the European Union appears similar to that of the United States, although because Eurostat and the U.S. Department of Commerce break down retail sales into slightly different categories, an exact comparison is not possible. That being said, clothes and accessories account for the largest percentage of sales in both the United States and Europe, followed by film and music in the EU (see figure 21). (Within the United States, film and music fall into the "other merchandise" category which is also second.) EU consumers purchase more books online, whereas in the United States consumers spend a greater share on electronic products.

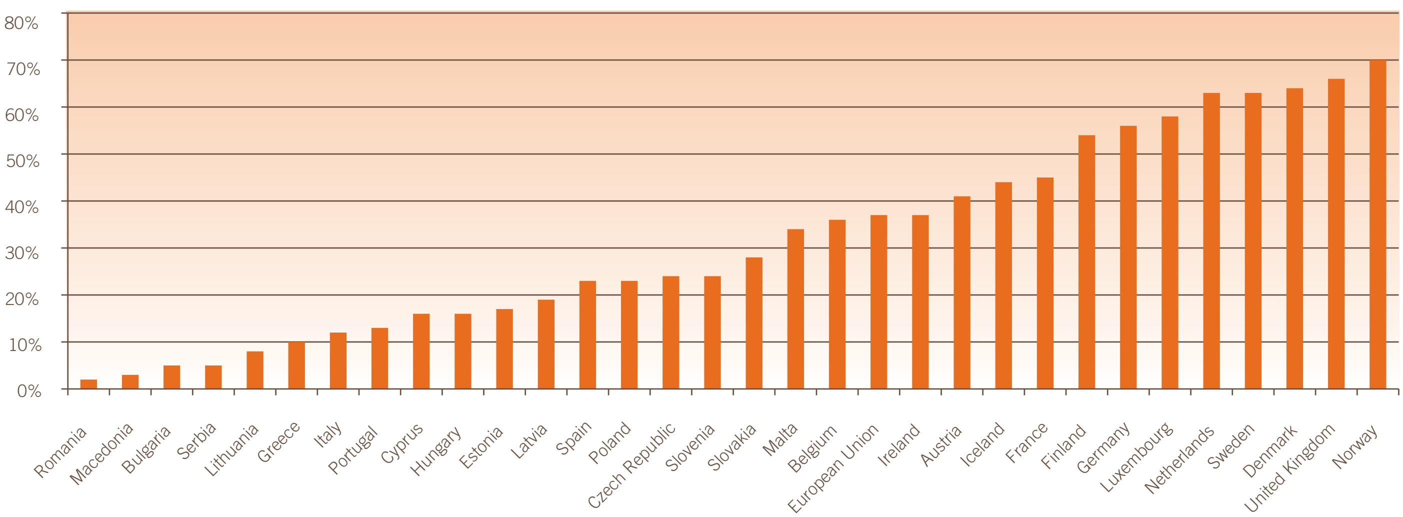
Figure 21: Percent of sales through e-commerce in the EU by product category, 2009



Source: EuroStat 2009[133]

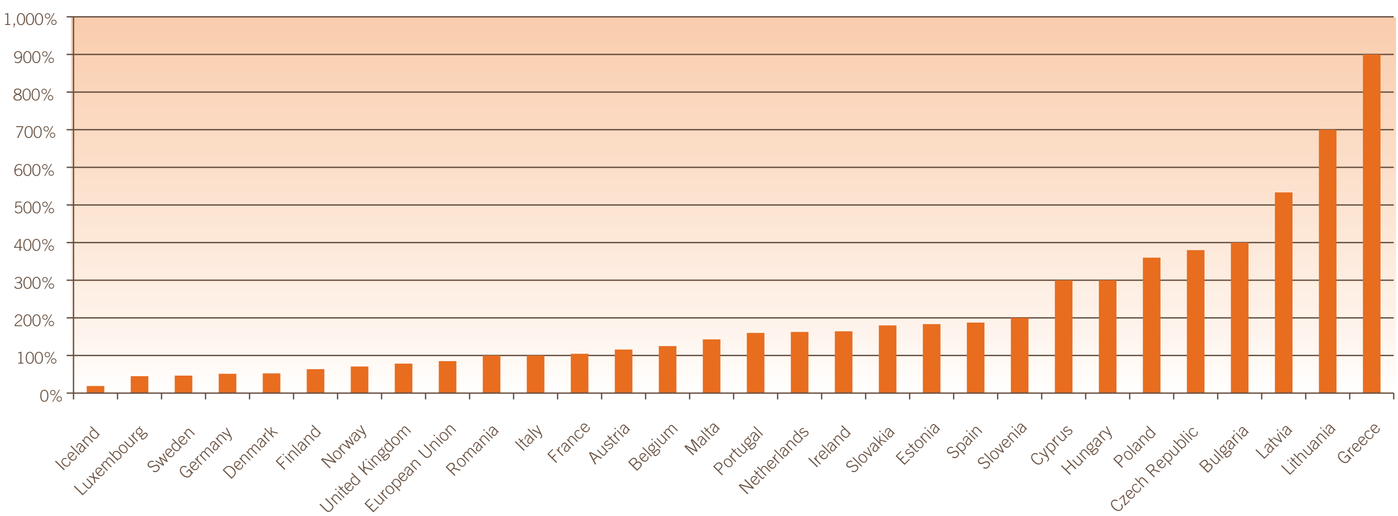
Figure 22 shows the percentage of European citizens, by country, who purchased goods or services over the Internet in the last 12 months, while figure 23 shows the growth in percentage of European citizens, by country, who purchased goods or services over the Internet in the past 12 months.

Figure 22: Percentage of European citizens who purchased goods or services over the Internet in the last 12 months, 2009



Source: EuroStat 2009

Figure 23: Percent growth of Europeans purchasing over the Internet within the last 12 months, 2003-2009

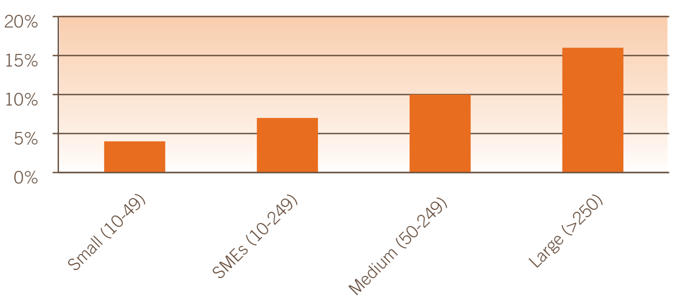


Source: EuroStat 2009

Dot-coms in Small Businesses

As in most regions, e-commerce adoption by smaller enterprises in Europe has been slower than by larger firms. In 2008, e-commerce sales as a percentage of total sales were four times as high in large firms (firms with greater than 250 employees) and 2.4 times higher in small-medium enterprises (SMEs; firms with 10 to 250 employees) than in small firms (those with 10 to 49 employees) as figure 24 shows. Not surprisingly, EU countries with SMEs disproportionately using e-commerce are leaders in overall B2C and B2B e-commerce. Ireland and Norway lead the EU with 24 and 13 percent, respectively, of sales amongst small firms coming from e-commerce, compared with the EU average of 6 percent. Surprisingly, three of the seven countries with higher-than-average sales from e-commerce for small businesses are in Eastern Europe, with Croatia (11 percent), Lithuania (8 percent), and the Czech Republic (8 percent) being among Europe's leaders. (See Appendix G for a full list of e-commerce in EU countries by firm size.)

Figure 24: Percent of e-commerce sales by firm size, EU27, 2009



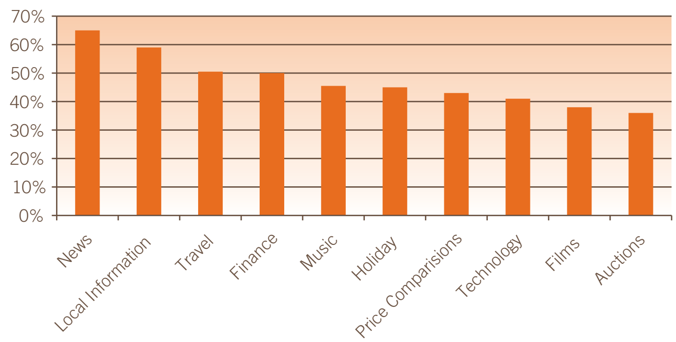
Source: EuroStat 2009

Dot-coms in Europe Beyond E-commerce

E-commerce figures neglect how online information gathering impacts consumption in Europe, as many shoppers research products online and then buy them offline. In fact, of the Internet users in Europe who have used the Internet to research products, a greater percentage purchased these products offline than online. Forty percent of European consumers regularly use the Internet to research products before buying and 59 percent cite the Web sites of popular brands as an important source of information. Indeed, between 2006 and 2007, the percentage of Europeans who sought out reviews or ratings before buying online increased by 42 percent. In Sweden, the number of consumers who contributed to ratings or reviews increased an astounding 383 percent over that timeframe. Yet online product information influences European consumers to differing degrees; online shoppers in the United Kingdom are the most likely to make a decision based on online information (50 percent) whereas Italians are the least likely to let online information affect their purchase decision (27 percent).[134]

While information gathering accounts for a large portion of Europeans' use of the Internet, an increasing number of Europeans use the Internet as a form of entertainment and as a way of staying connected with friends, family, and even strangers with shared interests. Between 2006 and 2007, the fastest growing use of Web sites in Europe was to watch videos (up 150 percent), view ratings (up 42 percent), download film or TV shows (up 18 percent), listen to podcasts (up 17 percent), and share data through P2P networks (up 15 percent). And 42 percent of European Internet users regularly communicate through social networking sites.[135] Figure 25 shows the top ten categories of Web sites by percent of use in the EU10, with news, information, and travel sites accounting for the top three.

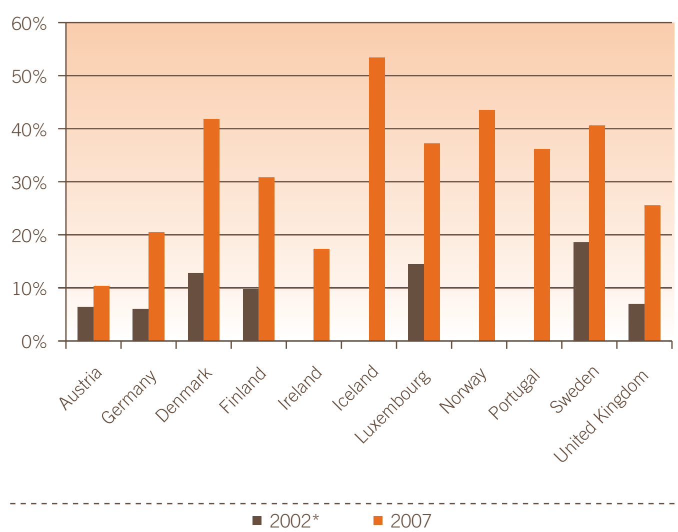
Figure 25: Top ten categories of Web sites, by percent of use in the EU10, 2008



Source: EIAA, 2009[136]

As more Europeans gain access to high-speed broadband, the Internet is rapidly taking the place of TVs and radios across the continent. In 2007, 32 percent of European Internet users (of the countries studied) watched TV online or listened to Internet radio, up from 9 percent in 2002. In Iceland, over 50 percent of citizens use Internet TV or radio (see figure 26).

Figure 26: Percent of Internet users in Europe using Internet-based TV or radio



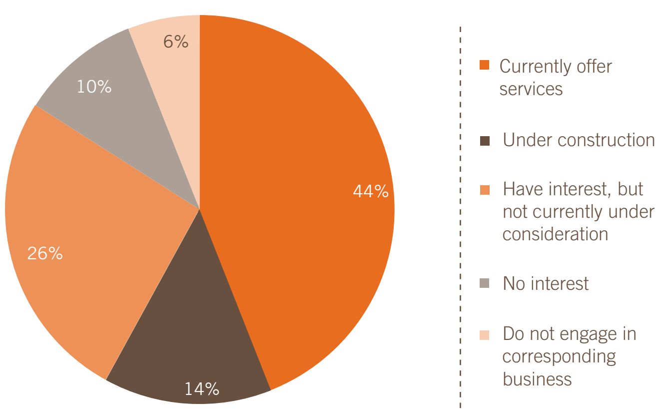
Source: OECD Information Technology Outlook, 2009.
** 2002 data not available for all countries.*

THE ASIAN INTERNET ECONOMY

As with Europe, despite large discrepancies across countries, the Internet economy is growing in Asia. Total B2C sales in Japan, Korea, China, and India were worth $51 billion in 2006, and are expected to reach $115 billion in 2010. Japan boasts the highest percentage of citizens using the Internet to buy goods and services (52 percent) in Asia (and the world) followed by Korea (45 percent), both significantly higher than the OECD average of 26 percent. As expected, other Asian nations, especially China, have much lower percentages of their populations involved in the Internet economy. Yet these figures are changing rapidly. It is anticipated that China will see large growth in B2C e-commerce in both absolute and percentage terms, growing from total online retail sales of $2.5 billion in 2006 to $18 billion in 2010, or 64 percent annual growth (compared to anticipated 17 percent growth over the same time period in Japan).[137]

Japan: Japan has a particularly strong mobile commerce market, including an $8.4 billion market for contactless mobile payments in 2008.[138] Although many of these payments come in the form of kiosk transactions through mobile phones, the portion of Japanese using mobile devices for traditional dot-com commerce is much larger than in the United States or Europe. Of enterprises selling to customers online, 44 percent have platforms for mobile devices, and another 14 percent of firms are in the process of developing mobile platforms (see figure 27).[139] B2B e-commerce in Japan also comprises a larger percentage than in many other countries. In 2008, B2B e-commerce was worth $1.8 trillion, or 13.5 percent, of total sales, up from 12.6 percent in 2006.[140]

Figure 27: Percent of e-commerce sites in Japan, by readiness for mobile devices, 2008



Source: Ministry of Economy, Trade and Industry [141]

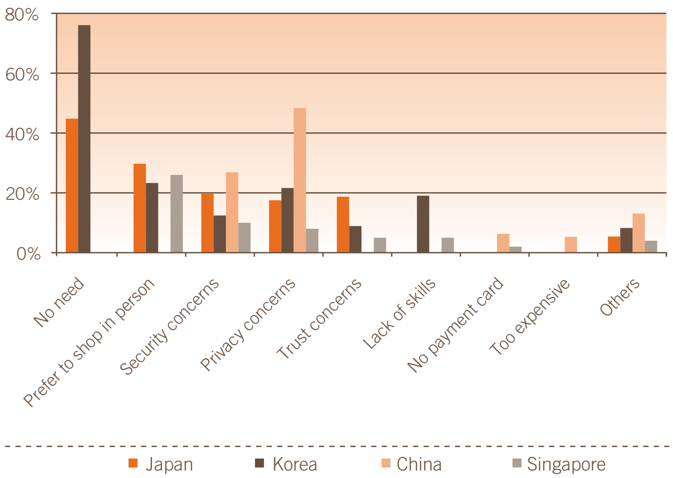
Korea: Although a leader in international broadband rankings, many firms in Korea have been slow to adopt e-commerce. However, this is changing. In 2006, roughly one-third of firms in Korea conducted e-commerce, up from 18 percent in 2004. Across firm sizes, as expected, a greater percentage of large firms (here defined as over 1,000 employees) participate in the dot-com economy than small firms (10-49 employees), 64 percent versus 30 percent. Yet having 30 percent of small firms selling over the Internet is particularly high for a middle-income economy such as Korea. Many consumers in Korea caught onto the dot-com economy early. By 2004, Korea was the first country in the world to sell more songs online than in stores. Indeed, between 2000 and 2006, Korea went from having 8,000 physical music stores to just 400, with the vast majority of music now being purchased online.[142]

China: Whereas Japan and Korea have the most mature dot-com economies in Asia, China is experiencing rapid growth in e-commerce. According to Analysys International, a Chinese-based e-marketing firm, total e-trade increased by over 100 percent in 2008.[143] With such explosive growth and the second largest Internet-using population in the world, 210 million (behind only the United States), many analysts believe that in time China will become one of the world's largest dot-com economies. However, regardless of its size, China has many hurdles to overcome to become a leader in the global Internet economy.

Despite having only 8 million fewer Internet users than the United States, Internet retail sales were just $2.5 billion in 2006, compared to $125 billion in the United States.[144] Thus, e-commerce represented only 0.06 percent of total GDP, 15 times less than the ratio of B2C e-commerce to GDP in the United States.[145] China thus clearly has a long way to go to equal the most advanced nations in per capita Internet use and e-commerce value. And in order to make progress in the dot-com economy, China will have to overcome numerous structural, cultural, and legal hurdles. In terms of the latter, China has tremendous identity theft and digital piracy problems, which create significant roadblocks to e-commerce. For example, China has the highest rate of illegally downloaded songs in the world, with 90 percent of downloaded songs stolen.[146] Why establish legitimate content sites when the market will be minimal because the government turns a blind eye to digital piracy? Furthermore, Chinese consumers' uncertainty with digital transactions has created substantial privacy concerns over e-commerce. As figure 28 shows, amongst Asian nations surveyed, the OECD found privacy concerns over online retail to be much higher in China than other Asian nations. Over half of Chinese do not shop online because of concerns over privacy, compared with just 20 percent of Japanese and 30 percent of EU27 counterparts.[147]

China also has a considerable way to go to create the right economic foundation for the dot-com economy, on both the demand and supply side. A lack of online payment methods amongst consumers in China limits their ability to use online retailers. For example, in 2007, there were over 1.5 billion credit cards in circulation in the United States, compared with just 50 million in China. Furthermore, Chinese SMEs have virtually no presence on the Internet, with just 100,000 SMEs out of 40 million selling products online. Few doubt that China is increasingly becoming a major global economic player, but without addressing these deep-seated structural, cultural, and legal issues, the dot-com economy will remain a peripheral component of China's economy.

Figure 28: Reasons for Internet users not buying online, select Asian countries, 2007



Source: OECD, 2009[148]

Social Networking in Asia

Social networking sites are a huge part of the Internet culture in Asia. Behind search engines, the most popular sites in Japan, China, Korea, and Singapore are fc2.com, qq.com, and facebook.com (for both Korea and Singapore)—all social networking sites.[149] Indeed, in Singapore, Friendster, the most popular social networking site, receives 940,000 unique visitors per month, just shy of 20 percent of the country's population. And Japan has the highest rate of blog readership in the world. While Internet users in Europe and the United States spend more time downloading music and videos and watching video clips online, in Asia the Internet is more often used as a way to communicate. Americans spend nearly three times as much time playing video games online as the Japanese, whereas citizens in Japan and Korea spend roughly five times as much of their time online on social networking sites than Americans. One reason for this is that social networking Web sites in Asia serve multiple purposes from blogging to personal communication. This is probably one of the reasons why Americans spend more time on e-mail Web sites than citizens in Japan, Korea, or Singapore.[150]

In Japan and Korea, ubiquitous high-speed broadband networks along with the most robust mobile communication infrastructures in the world have made uploading high-quality content via mobile devices extremely popular. However, in developing Asian nations such as China and Thailand, where first generation cell phones still dominate the market, fewer than 15 percent of mobile subscribers use their devices to go online.[151] Yet social media is being adopted in unlikely places throughout developing Asia. For example, 11 million of the 13.5 million Internet users in Malaysia blog or use social media.[152] One reason for this might be that in countries like Malaysia where the government has tight controls over traditional media, citizens leverage the anonymity of the Internet to express themselves.

THE INTERNET ECONOMY IN THE DEVELOPING WORLD

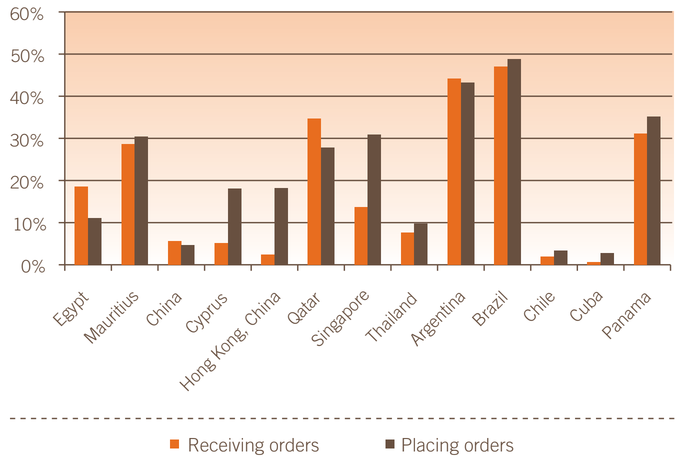
Although far behind OECD countries, some developing nations are making considerable inroads into the Internet economy. Between 2000 and 2008, the number of country code domain names belonging to non-OECD countries doubled from 20 percent of the global total to just under 40 percent. Over that timeframe, the number of country code domain names in non-OECD countries grew by 39 percent annually, compared to 25 percent in OECD countries.[153] And because many small countries predominately use .com addresses instead of specific country code Top Level Domains (ccTLDs), it is likely that the percentage of Web sites originating in developing nations is larger still.

The proliferation of devices and networks through which to tap into the Internet economy has played a crucial role in bringing the developing world online. In 1998, two-thirds of the world's ICT imports went to the developed world and only one-third went to developing nations. By 2007, over 45 percent of ICT imports went to developing nations with just over 50 percent going to developed countries. While it's worth noting that within the developing world Asia accounts for the vast majority of progress in technology adoption, Africa's ICT market has remained stagnant and Latin American's ICT imports have actually declined during the last decade.[154] However, the decline in ICT imports in several developing nations has had little to do with a lack of demand and more to do with protectionist trade policies that restrict importation of foreign-made technology.

Governments often promulgate such policies in a usually vain attempt to spur local ICT production. But given the combination of often embryonic domestic technology industries and rapidly expanding market demand in these countries, the outcome frequently is higher prices for ICT products and lost opportunities for citizens and businesses. In other words, these countries are placing too much emphasis on information technology production and not enough on how the use of IT by businesses and consumers can more extensively (and rapidly) drive economic growth in their countries.

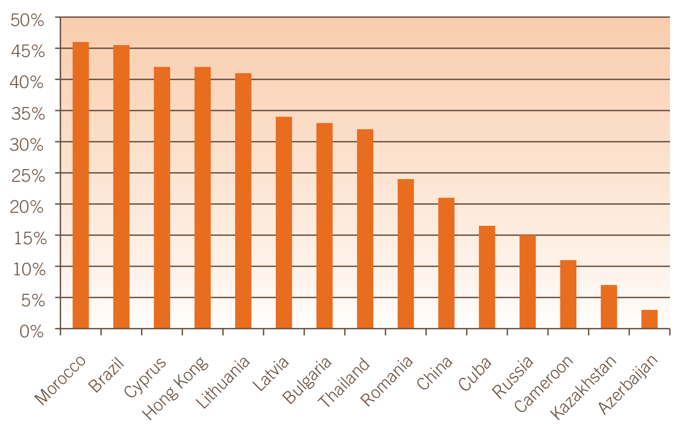
While in countries such as Switzerland, Sweden, and Japan over 80 percent of firms have Web sites, in many developing countries less than 50 percent of firms do so, and the majority of firms in these countries that do have a Web presence are large businesses. It is a rarity for micro, small, or medium-sized enterprises in developing countries to have a Web site, let alone to sell products or services online. Furthermore, these figures neglect the informal sector of the economy, which accounts for over three-quarters of non-agriculture employment in Africa and over 50 percent in Latin America.[155] Figure 29 shows the percent of businesses receiving or placing orders online for several developing nations. Figure 30 shows the percent of businesses with Web sites across a selected group of non-OECD countries.

Figure 29: Percent of businesses receiving or placing orders online, select non-OECD countries, 2008



Source: UNCTAD[156]

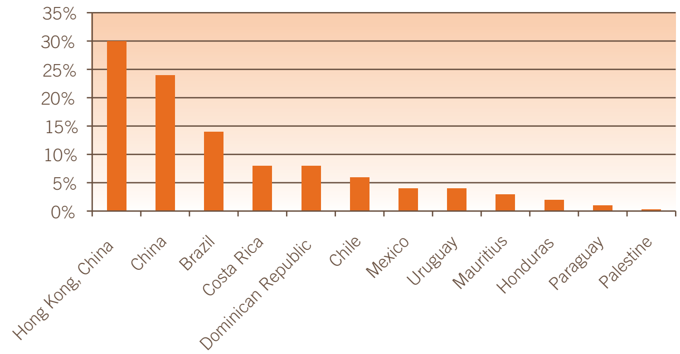
Figure 30: Percent of businesses with Web sites, select non-OECD countries, 2007



Source: OECD and Eurostat, 2008.

Yet despite its potential, actual sales via e-commerce remain low throughout the developing world. While data for all developing nations are not available, recent surveys of online shoppers in several developing countries indicate that the Internet economy in the developing world has a long way to go to reach that of the world leaders. Even in digitally advanced developing regions such as Hong Kong, only one in three Internet users has purchased goods or services over the Internet (and obviously, amongst the general population the percentage is much lower). And in many developing Latin American countries such as Uruguay, Honduras, and Paraguay, e-commerce is virtually non-existent. Furthermore, the data itself is likely to contain an information bias; countries with more pronounced digital markets are far more likely to have information on such markets than those with less developed e-markets. Therefore, it is safe to assume that e-commerce activity in most African nations, for example, is far below that of those countries represented in figure 31.

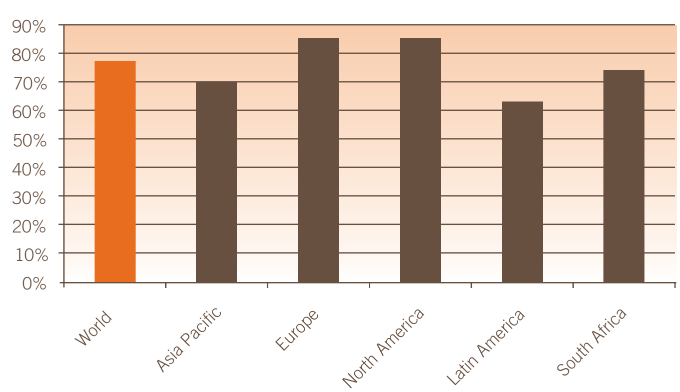
Figure 31: Percent of online population that has purchased online, select developing countries, 2007



Source: UNCTAD, 2007[157]

Cultural factors, such as fear of non-personal commerce or strongly community-oriented markets, are often said to explain the lack of e-commerce in much of the developing world. To be sure, culture always plays a role in the adoption of new technologies. However, it is important not to overstate cultural issues as a barrier to new methods of commerce, especially when doing so might suggest that individuals would be unlikely to use the Internet even if they had Internet access. Indeed, lack of Internet access seems to play a much larger role in explaining the limited amount of e-commerce in developing countries than cultural or other factors. For example, amongst those in the developing world with access to the Internet economy, a similar percentage of consumers purchase goods and services online compared with their counterparts in the developed world. As figure 32 shows, 85 percent of European Internet users have made an online purchase, as compared to 63 percent of Internet users in Latin America and 74 percent in South Africa, showing that individuals across these disparate regions are likely to engage in e-commerce activity, if they enjoy Internet access.[158] Contrary to popular belief, when the Internet economy is accessible, people everywhere seem to be interested in taking advantage of it.

Figure 32: Percent of Internet users that have purchased products or services online, 2008



Source: AC Nielsen Poll[159]

Just as the Internet helps consumers in the developed world research products and share where to find the best deals, the Internet has helped businesses in the developing world communicate beyond their traditional geographic networks. For example, a survey of e-commerce in Kenya's horticulture industry by the London School of Economics found that while few firms actually sold products online, the ability to exchange information with European buyers vastly increased the ease of exchange. Indeed, as one respondent noted, Kenyan firms had to drive their European counterparts to use the Web more often, "We had to push them, because telecommunications are so good in Europe, they were used to just calling someone; for us e-mail was a blessing."[160]

Eighty-five percent of European and North American Internet users have made online purchases, compared to 63 percent of Internet users in Latin America and 74 percent in South Africa, showing that citizens across all regions are likely to engage in e-commerce, if they enjoy Internet access.

The Internet economy will likely continue to grow in many developing nations as the cost of mobile and other Internet-accessible devices continues to decline and individuals gain higher incomes and are able to more easily afford Internet service. For example, between 2000 and 2004, within the developing world the cost of making a cell phone call declined by two-thirds and the number of Internet users tripled.[161] Going forward, both governments and the private sector will need to find the resources and resolve to scale up the Internet economy so the entire developing world can participate.

Just after the turn of the century, the staying power of the Internet economy was openly questioned. Yet the extraordinary expansion of the Internet to almost every corner of the world has disproven such criticism. While originally the product of the United States and initially used amongst a few technologically advanced, high-income countries, today the Internet economy is a stable medium for economic exchange across low-, medium-, and high-income countries alike. In many ways, a country's success in the Internet economy has become the modern hallmark of economic prosperity. In advanced and developing nations alike, dot-coms are fueling economic activity and promoting new means of social engagement in ways unimaginable only a few short years ago.

Custom Web-ordered Mini Cooper

One way in which the commercial Internet has fundamentally transformed business and the economy is by enabling the creation of entirely new business models or the application of age-old business models in ways never before possible. As David Newkirk, former CEO of consulting firm Booz Allen Hamilton, argues, "Ubiquitous connectivity has opened the floodgates of business model experimentation."[162] Indeed, the Internet has enabled the creation of business models that have rewritten the rules of entire industries, such as advertising. Many of these business models enable more efficient allocation of goods and services.

Many of these Internet-enabled or -empowered business models shift the boundaries of which party performs certain tasks in a value chain. This boundary-shifting is usually based on new possibilities created by the Internet or back-office IT systems.[163] In some cases, the service firm takes over some part of the customer's complexity, enabling the client to focus on its core business activity (for example, outsourced network management services offered by firms like Cisco Systems). In other cases, the service firm innovates by having the customer perform roles the company once performed (such as having customers select their own seats for a flight). If information technology is the production department of the services-era in much the same way factories and machines were for the goods-era, then the Internet serves as the trucks and roads of the Internet economy, connecting customers to a vast array of products and services.[164]

Table 9 lists 15 distinct business models (described subsequently) either substantially enabled or empowered by the commercial Internet. A number of dot-coms employ several of these business models simultaneously.

Table 9: Internet-enabled business models[165]

Internet-Enabled or Empowered Business Model	Definition	Examples of Companies Using Internet-Enabled Business Model
E-Delivery	Uses IT to undercut business models based on physical delivery.	E*TRADE, LendingTree.com, Esurance.com, ING Bank, NetFlix, iTunes, PayPal
Fractional ownership	Uses the Web to enable fractional ownership of capital assets, with the Internet enabling scheduling in time increments not previously practical.	ZipCar, FlexCar, NetJets, FlexJet
Marketing of excess capacity	Business models, often leveraging ICT, that identify and sell unused capacity.	Priceline.com, Total Quality Logistics, Lastminute.com
Dynamic pricing	Adjusts prices online in real-time in response to fluctuating supply or demand variables.	Dell, Amazon
Auction or matching markets leveraging the aggregation of supply and demand markets	Aggregates consumer demand and supply for products or services in one location, allocating supply and demand through auctions or matching.	eBay, Monster.com, Match.com, Expedia, GSA Auctions, Chemconnect
Create a new, Web-based platform for commerce	Uses the Internet to create an entirely new platform for commerce, monetized by inviting third parties to participate through it.	eBay, Amazon, Sitoa
Outsourcing and Cloud Computing	Company assumes complexity, capacity, or hosts services on behalf of client.	IBM e-Business On Demand, Amazon Web Services
Software-as-a-service	Enterprise-application software that customers do not have to license, but can access online over the Internet.	Salesforce.com, Google Apps
Pay-per-use plans	On-demand or per-pay-use services.	Progressive Insurance "Trip Sense" Program
Information-based, targeted offers	Uses data mining to develop targeted offers or services.	Collaborative filtering by Amazon, NetFlix, and Rhapsody
Mass customization	Uses ICT systems to introduce "mass produced, yet customized," also known as "mass customized" services.	Dell, Nike, Mini, Dow Corning
Anytime services	Internet enables always on availability of services.	Phoenix University, Concord School of Law, Cisco Systems, Ingram Micro
Ad-supported search, content, and services	Free content or search services for Web users supported by paid business advertising.	Google, Yahoo!
Social media/social marketplaces	Create a meeting place for people, enabling transactions.	Facebook, LinkedIn, Twitter, MySpace
Referral-based models	Receive a fee each time a sale is made through the referring Web site.	Weddingchannel.com, Yesmail

E-DELIVERY

E-delivery business models use the Internet to compete with business models that rely on physical presence or physical delivery to provide goods or services. A number of new financial services start-ups, including E*TRADE, Lendingtree.com, Esurance.com, and ING Bank, emerged to offer what they hoped to be more competitive Internet-based financial services business models because these firms did not have to support the financial overhead of physical retail locations. The success of these four businesses bears out the credibility of online business models in online trading, lending, insurance, and banking delivery. (Though certainly some early businesses such as Netbank failed in their efforts to market online financial services, many succeeded in establishing viable, sustainable online financial services delivery models.) No doubt the success of these Internet-based financial services start-ups contributed to driving established financial services firms into more quickly adopting the Internet and offering their own services online. Interestingly, Dutch financial services provider ING Bank was one of the very first in the world to offer customers online banking services. But ING had to introduce the service in the United States because Dutch officials, fearing the impact online banking would have on the employment of bank tellers, initially limited the introduction of Internet banking in The Netherlands.

The total consumer welfare gained from variety in books online has been estimated at $731 million to $1.03 billion annually, which represents between seven to ten times more welfare than consumers receive from just having access to lower prices online.

E-delivery models have been applied across a wide variety of industries to decrease the costs of physical overhead and to make the conversion from delivering physical products to digital goods. Services like iTunes have revolutionized the digital distribution of music and, increasingly, videos and television shows. Amazon successfully applied the model to compete with brick-and-mortar book retailers such as Borders and Barnes and Noble, as did Netflix against established video rental competitors Blockbuster and Hollywood Entertainment. As with financial services firms, the success of these Internet-based models drove established brick-and-mortar players to offer Internet-based offerings themselves.

Not only has Internet-based delivery changed the fundamental cost structure of these industries, it has opened up the opportunity for dot-coms to offer a far wider range of products to cater to the "long tail" of the marketplace. While brick-and-mortar book or music stores can only keep a finite inventory of titles on-site, the long tail refers to the ability of Web-based merchants to offer a much broader selection, opening up the opportunity to monetize the sale of more obscure, less-frequently demanded titles that would not be economical to stock in retail environments. The "Long Tail Theory," developed in 2004 by *Wired* editor-in-chief Chris Anderson, goes a step further, suggesting that, as the Internet makes distribution easier (and makes consumers more aware of more obscure products) demand will shift from the most popular products at the "head" of a demand curve to the aggregate power of a long "tail" made up of demand for many different niche products.[166]

For example, while a typical large brick-and-mortar store carries 40,000 to 100,000 book titles, Amazon.com carries over 3 million.[167] This variety is possible because Amazon's large centralized inventories and market allow it to stock books that might not sell many copies in a year and would be prohibitively expensive to stock in a brick-and-mortar store. The total consumer welfare gained from this variety in books alone was between $731 million to $1.03 billion in 2000, which represents between seven to ten times more welfare than consumers receive from just having access to lower prices online.[168] Of course, Amazon now sells electronic books (e-books) as well via its Kindle e-book reader, of which Amazon has already sold more than 3 million.[169] Amazon carries over 400,000 e-book titles, and finds that (when it carries both physical and e-book titles) it sells six Kindle books for every ten physical books.[170]

The long tail doesn't occur just in book retail, it applies for virtually any product distributed on the Web, from music to videos. For example, Posters.com stocks over 300,000 different posters. Ties.com stocks over 2,500 different ties. Online DVD rental site Netflix stocks over 100,000 different DVD titles, compared with a typical neighborhood video store that stocks around 3,000. Approximately 40 percent of sales at online music service Rhapsody are songs that are not available in brick-and-mortar music stores.[171]

Looking at the Long Tail Theory in depth in 2009, researchers at the University of Pennsylvania's Wharton School of Business found mixed evidence. For example, data provided by Netflix of customers using its Web-based movie rental service revealed that 15 percent of total demand came from titles beyond the top 3,000, the amount typically stocked in a video store.[172] However, despite the fact that that the number of peer-rated movie titles available from Netflix increased from 4,470 in 2000 to 17,768 in 2005, the researchers found that demand for the top 20 percent of movies increased from 86 percent in 2000 to 90 percent in 2005, suggesting that the traditional "80-20" rule may outperform the Long Tail Theory in explaining the distribution of online movie rentals.[173] Regardless, it is unquestioned that the Internet has created unprecedented opportunities to cater to long tail markets by substantially decreasing the marginal cost of doing so.

FRACTIONAL OWNERSHIP

Fractional ownership models, such as time shares for condominiums, have long existed, but before the Internet's arrival they had not been widely applied to a wide range of capital assets such as automobiles (ZipCar and FlexCar) or private jets (NetJets and FlexJet). Not only does the Internet enable companies like ZipCar to aggregate local demand for vehicles, it also allows access to the vehicles to be scheduled in time increments not previously practical with fractional ownership models. It's one thing for a property management company to manage 52 one-week visits to time-shared condominiums a year; it's another thing entirely to schedule ZipCar reservations in half-hour increments. NetJets pioneered the concept of fractional jet ownership, giving individuals and businesses all the benefits of whole aircraft ownership at a fraction of the cost.[174] FlexJet also offers fractional ownership of private jets, with share sizes starting at 1/16 of an aircraft (equivalent to 50 flight hours per year). One can make private jet reservations with as little as six hours' notice.[175] Other dot-coms have applied Web-based fractional ownership models to farm services equipment, yachts, prestige cars, and of course, vacation homes.

A study of over 4,500 eBay auctions found that consumers extract a median surplus of at least $4 per eBay auction, generating up to $7.05 billion in total consumer surplus annually.

Likewise, house matching sites like CouchSurfing.com facilitate matching between travelers and residents willing to spare a bedroom or a couch, or just have a chat with travelers passing through.[176] Other online sites let travelers exchange places to stay. A person visiting Paris can stay in the house of a person there who is on vacation, as long as the visitor in turn lets someone stay in his house at home. Such systems expand the output of the lodging "industry" without requiring any new hotel rooms.

MARKETING OF EXCESS CAPACITY

The Internet offers a novel channel for firms to market their excess capacity. Priceline.com allows airlines to sell their unsold seats and hotels to place their inventory of unsold accommodations online, empowering customers to negotiate for these services in a number of ways, including by making binding bids for reservations. Other Web sites such as Lastminute.com display unused inventory for events and tourist attractions in addition to flights and hotel reservations.

The Internet has actually had a profound impact on the long-haul freight trucking industry. Because of difficulty in predicting demand, transportation equipment is often underutilized. For example, trucks might be fully loaded for delivery, but might make the return trip partially or completely empty. Indeed, about one-fifth of trucks at any one time are "transporting air."[177] Because of the Internet, trucks can operate more efficiently. Web sites like Getloaded.com and Internet Truckstop.com act as a matching service, precluding excess capacity from going to waste by connecting truckers that would otherwise be traveling empty with loads that need to go to the same destination.[178] One study found that on-board computers linked to the Internet allow managers to better coordinate trucks, boost capacity utilization by 3.3 percent, and have saved $16 billion annually in the $500 billion trucking industry.[179] As a result, this has reduced the overall number of miles driven and thus reduced the carbon footprint of the industry relative to what it would have been without the technology. Ohio-based Total Quality Logistics has built an almost billion dollar business in part through leveraging the Internet to facilitate the shipment of less-than-truckload freight in the United States.[180]

DYNAMIC PRICING

Dynamic pricing allows companies to operate more efficiently by pricing their product differently depending on different variables and by using pricing to better control demand. Many brick-and-mortar retailers already do this. For example, department stores regularly have end-of-year clearance sales to quickly move out last year's inventory. But using the Internet, businesses can implement much more granular dynamic pricing strategies. For example, Dell can lower or raise its prices based on factors such as fluctuations in costs, availability of components in its supply chain, and changing customer demand. Buy.com, a low-price online retailer, frequently changes pricing on its handheld products in response to changing market conditions. Dynamic pricing delivers two main benefits for companies. First, it provides new opportunities for customers to maximize their return per customer because, by lowering the "menu cost" (the cost of displaying prices to customers), companies can post and frequently change prices for different channels and product configurations. Secondly, dynamic pricing can bring better returns on deployed assets. That is, with dynamic pricing, companies can encourage demand in slow periods and discourage it, if necessary, during peak periods (for example, if peak demand is causing bottlenecks in the supply chain for critical components).[181] Of course, firms can also leverage dynamic pricing as another avenue to market excess capacity.

SIMULTANEOUS AGGREGATION OF SUPPLY AND DEMAND MARKETS

The Internet enables the simultaneous aggregation of both supply and demand for almost all industries on a scale never before possible, dramatically extending the applicability and power of both auction and matching markets. For example, eBay leveraged the Internet to become the world's largest online marketplace, where practically anyone can buy and sell practically anything, with the total worth of goods sold on eBay in 2009 amounting to $60 billion, or $2,000 every second.[182] Bapna, Jank, and Shmueli found that (based on a study of 4,514 eBay auctions), consumers extract a median surplus of at least $4 per eBay auction. Their study found that eBay's auctions generate up to $7.05 billion in total consumer surplus annually.[183]

In effect, online jobs sites such as Monster.com, CareerBuilder, and The Ladders reflect the demand and supply aggregation model, seeking to connect job seekers with employers. eHarmony and Match.com offer similar matching services for dating. Such aggregation models can be found for any number of industries and sectors online, from used oil and gas field services equipment at Oilfield-auction.com to apparel and electronics at Overstock.com. The Pan European Fish Auction (Pefa.com) directly links fish retailers to fish harvesting companies through real-time auctions.[184] Chemconnect.com connects buyers and sellers of chemicals into a more efficient online market.[185] Though not a dot-com, even the U.S. government offers the general public the opportunity to bid electronically on a wide array of surplus, seized, or forfeited federal assets at GSAauctions.gov.

NEW WEB-BASED PLATFORMS FOR COMMERCE

EBay, however, represents more than just an auction market. It has become an entirely new online platform for commerce, to the extent that 724,000 Americans report that their businesses or transactions on eBay constitute their primary or secondary source of income.[186] Amazon.com represents a similar platform for commerce by allowing affiliated associates to sell products online, in direct competition to Amazon's offerings. As many as 8 million individuals sell books through Amazon's platform.[187]

The start-up Sitoa.com has built a similar Web-based commerce platform. Sitoa built a Web-based, transactional "e-tailing" engine that seamlessly connects online retailers with product suppliers in the e-commerce marketplace. Sitoa's e-tailing engine allows product suppliers to easily load their product inventory onto Sitoa's Web-based platform, which online retailers can readily visit to select and upload products they want to sell on their Web sites. A key insight behind Sitoa's "One Source Model" is that the supplier handles order fulfillment directly on behalf of the online retailer, shipping products purchased through the retailer's site directly to the customer. This "supplier-direct fulfillment model" offers two advantages: 1) The online retailer need not maintain extensive and expensive inventories at its location, and 2) Because the online retailer need not manage physical inventory, it can sell inventory-intensive product categories online, allowing the online retailer to offer a much greater diversity of product categories through its Web site. By enabling them to market a much richer set of products, Sitoa helps online retailers realize incremental revenues and increased profits.[188] In essence, Sitoa.com has significantly reduced the cost structure of online selling by creating a technology platform that seamlessly links network nodes—online retailers and their product suppliers—through direct data transfer via the Internet. It should also be noted that this is another manifestation of electronic data interchange (EDI) moving to a Web-based platform. As Sitoa CFO Eric Hassman explains, "America's largest retailers have more than 30,000 suppliers, but they only electronically integrate about sixteen of these suppliers a year into their data systems. Our system can get new suppliers set up and connected with hundreds of retailers in as little as a few hours."[189]

OUTSOURCING AND CLOUD-COMPUTING

The Internet empowers a number of outsourcing-based business models. For example, IBM's e-Business on Demand services allow clients the flexibility to access scaled computing services when needed, such as to manage peak periods of demand, instead of having to over-purchase depreciating capital assets. For example, mainframes are idle 40 percent of the time, UNIX servers are idle 90 percent of the time, and PCs are idle 95 percent of the time.[190] The Internet thus allows corporations to tap into additional computing power on an as-needed basis. Another manifestation of this model is grid computing, which enables the sharing, selection, and aggregation of a wide variety of geographically distributed computational resources (such as supercomputers, compute clusters, storage systems, and data sources) and presents them as a single, unified resource for solving large-scale and data intensive computing applications (e.g, molecular modeling for drug design, brain activity analysis, and high energy physics).[191] In contrast to grid computing, which leverages the Internet to aggregate the computing power of otherwise dormant machines, cloud computing describes a new delivery and consumption model for IT services based on the Internet, typically involving the provision of dynamically scalable and often virtualized resources as a service over the Internet.[192] For example, Amazon offers a suite of cloud computing services called Amazon Web Services that allows companies to dynamically requisition computing and storage resources to meet current demand. For example, using Amazon Simple Storage, a company can "store and retrieve any amount of data, at any time, from anywhere on the Web."[193] Using cloud computing, companies can better manage spikes in demand so that the Web service itself can automatically scale up or down to ensure best performance while only paying for the resources they use.

SOFTWARE-AS-A-SERVICE

Cloud computing dramatically empowers the potential for software-as-a-service (SaaS) business models, such as those offered by Salesforce.com or Google. SaaS enables customers to access enterprise application software via the Internet, often without having to acquire an enterprise site license. SaaS business models leverage the Internet to deliver software applications that once were sold as shrink-wrapped software with the application installed and managed on the user's PC desktop. Delivering such applications through the Internet confers a number of benefits: software and system updates can be performed behind the scenes, without requiring customers to install new software versions, and customers can access their applications and data anywhere they can connect to the Internet, without having to be tied to a desktop. More fundamentally, SaaS allows companies to shift to a subscription-based, pay-as-you-go business model from a shrink-wrapped software sales model. For example, Salesforce.com has revolutionized the customer relationship management (CRM) market by offering Web-based CRM services. The SaaS market was believed to have grown to a $6.3 billion global market by 2006, and was expected to reach $7.7 billion in 2007.[194] Google Apps is a Web-based word processor, spreadsheet, presentation, and data storage service allowing users to create and edit documents online while collaborating in real-time with other users. Microsoft's Office 2010, the newest version of the company's venerable office productivity software, will also make its Word, Excel, PowerPoint, and Outlook applications Web-deliverable.

PAY-PER-USE PLANS

Connecting the Internet to physical devices enables such pay-as-you-go business models to be applied to entirely new industries. For example, Progressive's TripSense service uses a device plugged into a USB port on a vehicle to collect actual information on a motorist's driving behavior, such as how many miles are driven, when the motorist is driving, at what speeds, and whether there are excessive instances of extreme acceleration or deceleration. At monthly intervals, drivers remove the device from the vehicle, insert it into their computer, and upload the data via the Internet to Progressive, which adjusts the driver's insurance rates based upon their demonstrated safe driving behavior. This enables Progressive to reward drivers with lower premiums for traveling less, or more safely. As the Internet enables businesses to network together a multitude of devices and sensors, a wealth of similar new services and business models are likely to emerge.

COLLABORATIVE FILTERING AND INFORMATION-BASED, TARGETED OFFERS

Through information-based, targeted offers, companies can build business models based on using sophisticated data mining to develop targeted offers and services. Perhaps the most celebrated example is Amazon's collaborative filtering approach, which makes book recommendations to customers by combining knowledge of the customer's past selections with similar purchases made by other customers displaying similar interests. A number of dot-coms have applied the collaborative filtering principle, including Netflix to make film recommendations based on the movie genres or most common actors or actresses in the films one watches most often. Rhapsody.com and Apple's iTunes Genius feature make music recommendations on a similar basis. Netflix has devoted substantial resources towards improving its predictions of user's ratings of movies, including sponsoring a $1 million competition to develop an algorithm that would lead to a 10 percent improvement in predicting the ratings its customers will give to movies.[195]

MASS CUSTOMIZATION

The Internet dramatically expands firms' ability to mass produce customized products and services for customers. Dell Computer pioneered this approach with its use of the Internet to enable build-to-order personal computers. Interestingly, the most profitable aspect of Dell's business model was not simply the mass customization aspect, it was that Dell could also reduce its inventory and recognize income before having to pay suppliers. That is, when customers completed their custom-configured online order, they paid for the item in full at check-out. Only then would Dell turn around and order the specific components from parts suppliers, dramatically reducing the amount of inventory Dell had to keep on hand. Moreover, Dell recognized revenue from the consumer's purchase immediately, often days before the customer received the final product or vendors had to be paid, significantly enhancing the firm's cash flow position vis-à-vis competitors.

Web-based build-to-order business models have since been applied to any number of products and services. Lands' End lets customers submit measurements online to receive custom-fit clothing and Nike's Web site allows customization of athletic footwear. American Quantum Cycles lets customers order bikes online to fit their unique measurements. Using the Internet to receive orders, CafePress takes basic commodities like t-shirts, hats, and coffee mugs, and then prints onto them designs submitted by customers.[196] Parypongtable.com lets users design their own game tables, including the type of legs, logos, etc. Web site digitalforming.com goes a step further. Proclaiming that they are democratizing personal objects, the site provides three-dimensional software solutions to help individuals co-create and co-design products with professional designers.

> Many Internet-enabled business models shift the boundaries of which parties perform certain tasks in a value chain, with this boundary-shifting usually based on possibilities created by the Internet or back-office IT systems.

The BMW-owned Mini brand popularized the practice of allowing customers to design their own vehicles over the Internet. Scion (a Toyota brand) adopted this practice and is probably the second-most mass customized automobile brand in the world. CATER is an initiative launched by European and Asian players in the automotive field to develop an integrated system for mass customization of vehicles, including through online configuration.[197] Unfortunately, American automobile manufacturers have limited ability to offer build-to-order, mass customized automobiles over the Internet due to automobile franchise laws in all 50 U.S. states that prohibit U.S. automobile manufacturers from selling vehicles directly to customers over the Internet (rather than through locally franchised dealers).[198] Such regulations harm consumers and automobile manufacturers alike.

Established manufacturers have also thoroughly incorporated Web-based build-to-order systems into their supply chains. For example, generator-making giant GE Power Systems has installed one of the world's largest manufacturing execution systems (MES). GE Power Systems has implemented the near-paperless, digital-based, build-to-order MES at its plants worldwide.[199] To help its dealers manage inventories more effectively, General Motors developed a service called SmartAuction. For vehicles that are coming off lease, SmartAuction asks customers to bring in cars for inspection before the lease expires. The condition of the car is logged into the system and sent to GM dealers who use it to purchase cars electronically. The system helps dealers find cars that fit their target audience, manages the auto-titling process, and shortens the time cars are carried in inventory.[200]

Dow Corning's Xiameter Web-based business model, which offers customers a self-service option for purchasing silicone products and applications over the Internet, was hailed by one Harvard Business Review case study as a "major transformative success" that "re-invented the company."[201] As the case study noted, Dow's business model had been "based on high-priced, innovative product and service packages…but many customers experienced in silicone applications no longer needed technical services; they needed basic products at low prices." Dow leveraged the Internet to create a fundamentally lower cost structure dependent upon a new IT system that offered a standardized, self-service process for its customers. Whereas Dow Corning had previously had no online sales component, 30 percent of the company's sales now originate online, nearly three times the industry average.[202]

ANYTIME SERVICES

The Internet further enables an entirely new set of anytime, always available services across a range of industries. For example, the University of Phoenix offers online college education. The Concord School of Law allows students to complete a law degree over the Internet. As they note, the "law degree curriculum is available 24-7; before dawn, on your lunch hour, or after work."[203] The National Center for Education Statistics estimated that there were a total of 12.2 million enrollments in college-level credit-granting distance education courses in 2006–2007. Of these enrollments, 77 percent were reported in online courses, 12 percent were reported in hybrid/blended online courses, and 10 percent were reported in other types of distance education courses.[204] As of February 2009, e-learning was estimated to represent about 10 percent of the overall U.S. training and educational market.[205]

Another type of Internet-enabled "anytime, always on" (and outsourcing) business model would be managed network services, such as those offered by Cisco Systems, Ingram Micro, or Rackspace.com. Such services include, for example, remote network monitoring and management services for small enterprises. Such services can proactively diagnose failure modes in advance, performing system maintenance before network outages occur, or can fix network or computing system problems remotely, without having to send a technician onsite. Managed services can help businesses reduce overall network costs by 15 to 25 percent.[206] The total U.S. managed network services industry grew from $7.9 billion in revenue in 2000 to $31.4 billion by 2006, a compound annual growth rate of 22.4 percent.[207]

AD-SUPPORTED SEARCH

Led by Google, the Internet-based, ad-supported-search business model has revolutionized the advertising industry. Indeed, online advertising, a $40 billion industry in 2008, is projected to double into an $80 billion industry globally by 2011.[208] The old saw in the advertising industry went, "We know half of our advertising budget is wasted; we just don't know which half." One of Google's breakthroughs was to leverage the Internet to give advertising customers real-time visibility into the effectiveness of their targeted advertising campaigns. That is, they leverage real-time information to let advertisers know which ads are working and which aren't. Google leveraged that breakthrough to become the highest market-valued corporation in the world. Overall, four of the five most trafficked Web sites in the United States are ad-supported search engine/portals, including Google, Yahoo!, msn.com, and Ask.com.[209]

SOCIAL MEDIA

The Internet has spawned a number of dot-coms leveraging social media-based business models that offer an online meeting place for people and monetize the destination through transactions or advertising. Facebook, LinkedIn, Twitter, and MySpace are but a few such Web sites, and they are beginning to generate revenue. Facebook expects to make at least $500 million in 2009, and a recent investment in the firm by a Russian investor group placed the firm's valuation at over $10 billion.[210] (A 2007 Microsoft investment valued Facebook's preferred stock at approximately $15 billion.) No doubt the spread of social media dot-coms has powered the Web 2.0 vision of the Internet.

REFERRAL-BASED BUSINESS MODELS

One of the earliest Web-based business models was the referral model, which paid affiliate sites to direct traffic to target Web sites. This model very much dominated the early days of the Internet when Web sites were largely valued on the number of "eyeballs" they attracted. Nevertheless, referral-based business models remain viable on the Internet. For example, WeddingChannel.com provides a bridal registry where wedding guests can buy gifts from companies such as Tiffany's, Macy's, or Crate & Barrel, with WeddingChannel.com receiving a fee each time a sale is made through its Web site.[211] Yesmail.com, which generates leads using e-mail marketing, represents another referral-based example.[212]

In summary, the Internet enables a wealth of novel customer value propositions and business models, including those that enable businesses to manage some element of their client's complexity, enhance their productivity, increase transparency, remove or minimize business uncertainty, create multi-directional value propositions, maximize capacity utilization, or proactively anticipate and predict (or even repair) failure modes in advance.[213] The following section analyzes the overall economic impact of the commercial Internet.

Web-order fulfillment center

Most recognize that the Internet has transformed our lives and revolutionized commerce. The commercialization of the Internet has led to a wide array of benefits for consumers, businesses, and the economy at large. But what is the Internet economy? Defining it is more art than science. Distinguishing the Internet economy from the IT economy is difficult given the overlap between the two. The Internet economy is clearly a subset of the IT economy. For example, while Amazon.com is clearly part of the Internet economy, a computer-enabled machine tool in a factory is not. This report focuses on the parts of the economy enabled by the commercial use of the Internet, ignoring other uses such as the general use of IT or the Internet by non-profits and governments. But even with this focus, much of the benefits of the commercial Internet are underreported. For example, as MIT professor Erik Brynjolfsson notes, the total value that consumers get from Internet searches is not counted in any official output statistics, and thus far no research has even attempted to quantify it.[214]

This much is certain: before the dot-com era, companies were severely limited in their ability to conduct business electronically. Businesses that wanted to achieve greater efficiencies through using electronic means of communication were restricted to faxes, phones, and private networks used for electronic data interchange. Likewise, before the dot-com era, consumers had fewer choices, less information, and less power to influence prices and the quality of goods and services. As the next two sections of this report will document, the Internet economy has been, and will likely continue to be, one of the principal drivers of economic growth and quality of life for societies throughout the world. This section on the economic impacts of the commercial internet estimates the economic benefits of the commercial Internet and then examines how the Internet economy helps consumers, how it helps firms and workers, and how the Internet industry itself contributes value directly to economies.

ESTIMATING THE ECONOMIC BENEFITS OF THE COMMERCIAL INTERNET

The IT revolution has had a major impact on the global economy. For example, ITIF has estimated that because of the impact of the IT revolution, the U.S. economy is approximately $2 trillion larger in terms of annual GDP than it would be otherwise. But this measurement includes not just e-commerce and the activities of the commercial Internet, but also other IT impacts, such as the use of electronic kiosks, more efficient IT-enabled machines in factories, and software systems in enterprises.

Measuring the economic impact of the Internet economy, in contrast, is a more complex task. In large part, this is because it is difficult to measure only the e-commerce component of the IT economy. However, given existing data it is possible to come up with a general estimate of the impact of the commercial Internet on both overall GDP and consumer welfare. This report does this not by measuring the direct economic impact of Internet firms (e.g. the Yahoo's! and Google's of the world). In some ways the shift of economic activity to the Internet industry cannot be counted as an economic benefit, because if this economic activity did not take place in the Internet industry, it would occur somewhere else (people might buy more consumer electronics or clothing, for example).

However, what one can and should measure is the impact of the commercial Internet on productivity and therefore GDP. Estimates vary depending on the study and methodology. One study found that the cost savings from global business use of e-commerce were $1.25 trillion by just the mid-2000s, at a time when global e-commerce transactions were around $4.9 trillion, for a savings ratio of 25 percent.[215] A UK study found that firms that engage in both e-purchasing and e-selling had 15 percent higher value added per worker, equivalent to reducing the cost of goods sold by around 5 percent.[216] With average e-commerce sales amounting to 15 percent of total retail sales, the savings ratio is 33 cents per dollar of e-commerce transactions. Another study estimated that e-commerce reduced the cost of goods sold by approximately 7 percent in the United States. With average e-commerce sales of 16 percent, the savings ratio is 43 cents per dollar of e-commerce transactions.[217] Cost savings in Germany, the United Kingdom, and France were lower, on the order of 5 percent of the cost of goods sold. With average e-commerce sales of 14 percent, the savings ratio is approximately 35 percent.

Litan *et al*. estimated that the commercial Internet would lead U.S. GDP to be $590 billion larger than it would be in its absence.[218] This amounts to 4 percent of GDP and 15 percent of overall e-commerce transactions. Therefore, using a conservative estimate, it seems reasonable to use a savings ratio of 15 percent per dollar of e-commerce.

In 2010, global e-commerce activity totaled an estimated $10 trillion. Using an estimated savings of 15 percent, this means that without the commercial Internet, the global economy would be $1.5 trillion smaller than it would be otherwise. The share of e-commerce conducted through dot-com domains is smaller, however ITIF estimates that it is still substantial, generating an estimated $400 billion in economic benefits annually throughout the world, an amount that is expected to grow to at least $950 billion annually by 2020.[219] To put this into perspective, the economic benefits of the commercial Internet are larger than the global sales of medicine, investment in renewable energy, and government investment in R&D, combined.[220] And if e-commerce continues to grow annually half as fast as it grew between 2005 and 2010, then by 2020 global e-commerce will reach $24.2 trillion, and will add roughly $3.8 trillion annually to the global economy—more than the total GDP of Germany.

THE INTERNET ECONOMY HELPS CONSUMERS

The commercial Internet has provided the most significant improvements in consumer welfare since the emergence of the post-World War II mass production economy. Consumers today are able to make better decisions, obtain more products and services (many of which did not exist before the Internet), and enjoy more convenience.

Making Markets More Efficient by Expanding Consumer Access to Information

Over the past century, a host of institutional innovations have emerged to provide consumers information and assurance about the products and services they were considering buying, from advertising to warranties to publications like *Consumer Reports*. But nothing has revolutionized shopping quite like the Internet. Consumers equipped with knowledge about a product's price, availability, and quality can find the best combination of goods and services for their money. The Internet has moved consumer empowerment to a new level by lowering the main hurdle to getting comprehensive information on prices and products: search costs. The Internet makes it dramatically easier to find information on products and services, including prices and quality. For example, by using Google's or Bing's shopping search engines, consumers can easily compare prices for the same item or service. Now, instead of relying on the Sunday paper to learn when sales are happening, one can quickly and easily compare prices among multiple stores online.

> Online tools to compare life insurance policies between providers have reduced on- and off-line prices of life insurance by 8 to 15 percent, producing a consumer surplus of $115 to $215 million annually.

Saving Money: A number of studies have shown that e-commerce saves consumers money. For example, buying contact lenses over the Internet enables consumers to save between 10 and 40 percent of the cost of buying from an optometrist.[221] A Yale University study found that the average customer using an online service to buy a vehicle pays approximately 2 percent less than someone buying in person from a dealer; these savings would likely be even greater if consumers could go online and buy a car directly from the manufacturer.[222] Studies have even found that, on average, prices at pure-play e-tailers are lower than at brick-and-click e-tailers.[223] By establishing more cost-efficient operations online—especially by reducing the costs of acquiring and maintaining expensive physical retail locations—the Internet enables pure-play dot-coms like Amazon and Netflix to offer ever more competitive pricing, exerting further downward pressure on consumer prices for books, movie rentals, music, and the many other products and services sold online.

Even if they purchase from a brick-and-mortar store, Internet users can still benefit. For example, when consumers want to know where the cheapest gas is they can go to GasBuddy.com. The site collects real-time prices from some 750,000 volunteer price "spotters," who send in daily updates from their local stations. With prices varying by up to 50 cents from one gas station to the next in some cities, it pays to stay informed.

This increased ease of price comparison leads to significant savings for consumers. Price comparison Web sites make consumers more sensitive to prices, reducing price dispersion and increasing the relative importance of differences in retail services, such as delivery options and ease of Web site use, in deciding whom to buy from.[224] For example, online tools to compare life insurance policies between providers have reduced on- and off-line prices of life insurance by 8 to 15 percent, producing a consumer surplus of $115 to $215 million annually.[225] Overall, the ease with which consumers can compare prices online has made consumer demand extremely price-sensitive and led companies to lower prices.[226] This increase in bargaining power by Internet-empowered consumers is one reason why the Pew Research Center' Internet & American Life project found that 32 percent of online Americans say that the Internet has greatly improved their ability to shop.[227]

Consumers Trump Madison Ave.: The Internet also makes it easier for consumers to get more information to make better purchasing decisions. In the past, brands were one way consumers could gain assurance of product or service quality. But establishing brand reputations can be quite expensive and can lead to higher prices. However, the increased information available through Internet shopping and third-party product review sites has decreased the effectiveness of branding.[228] With the Internet, consumers no longer need to rely on past performance of producers or celebrity endorsements to make their purchasing decisions. Customers' online reviews provide information on products and services independent of producers. Community rating systems allow consumers to get recommendations on the kinds of books or movies they might like based on what other, similar users liked. Consumers can also use the Internet to try a product before they buy it. For example, readers can preview many books at Google, Amazon, or BarnesandNoble.com. Overall, two-thirds of U.S. consumers use the Internet to research purchases before going to the store.[229]

Ads Just for You: Another way in which the Internet increases consumer information is by enabling more targeted advertising. Instead of being subjected to irrelevant ads for products most consumers would never want or need, targeted online ads are more likely to appear for items in which a consumer is likely to have a real interest. For example, with Google AdSense, advertisers can advertise to only those people who have demonstrated through their search terms that they are interested in the advertised product type.[230] And targeted online ads can be integrated into many types of Web sites. For example, if a person has booked several trips to Las Vegas several times a year on a travel Web site, the next time the person goes to the site it can display special Las Vegas flight and hotel packages. Such targeted marketing not only is much more likely to provide information of value to a consumer, it significantly increases the value of the marketing to the companies, thereby lowering the relative cost of advertising and further reducing prices.

Lowering Prices by Enabling Self-service

Thirty years ago, futurist Alvin Toffler predicted the rise of "prosumers"—consumers who share in the production process when they consume. But it took the rise of the Internet economy for his prediction to come true. Today, self-service is a vitally important part of the economy.

Consumers can use the Internet to do for themselves what they used to have to pay professionals to do for them. For example, individuals can use self-service technology for their legal needs. Using online legal services, individuals can draw up a will, lease, or other simple contract and save 75 to 80 percent over using a lawyer.[231] Similarly, individuals can use companies such as E*TRADE or Charles Schwab for Internet stock trading, rather than using a stockbroker. Moreover, for individuals looking to manage their own money, investment strategies were once limited by the lack of access to robust, real-time information. Now many individuals choose to forgo stockbrokers to manage their own investments because there is very little information available to professionals that cannot be found by amateurs through online research. Moreover, purchasing a stock or bond now requires only a few clicks online. In Japan, online trading has exploded, with the number of accounts at Japanese electronic brokerage firms growing from fewer than 300,000 to nearly 8 million since 1999, with Internet trading now accounting for more than one-quarter of all equity trades in the country.[232] Using the Internet for equity trading has contributed to the price of equity trading declining by as much as 90 percent.[233] Between 10 and 20 percent of U.S. equity trading now occurs over the Internet.[234]

Self-service technology also allows consumers to take on many of the functions provided by travel agents. Consumers can research and plan their own itineraries using the thousands of online resources that offer detailed information about destinations. Web sites like Orbitz and Expedia let consumers bypass travel agents and directly make air, hotel, and car reservations. Neither must consumers rely on the advice of a single agent for travel recommendations—Web sites like TripAdvisor, Virtual Tourist, and IgoUgo offer detailed suggestions on where to stay, what to eat, and where to visit while traveling. As a result, the use of travel agents has declined substantially. Today only 25 percent of car rentals, 30 percent of hotels, and 50 percent of airline tickets are booked through travel agents.[235]

Consumers also use the Internet to purchase insurance, a task once only fulfilled by an insurance agent or broker. Using the Internet, consumers can research costs and benefits of various types of insurance, including property, life, health, disability and long-term care, rather than relying exclusively on an agent for this service. Consumers can use online tools to request quotes and submit applications. For example, Geico offers discounted insurance, in part because it is able to have its customers use self-service options to manage their insurance. Using the Geico Web site, policyholders can view their current insurance options and policy documents, make changes to their policies, such as changing a deductible or modifying their coverage, and make an online payment. As a result of self-service technology, insurance agents and brokers can service more clients and spend their time on more complex issues, such as answering insurance questions. U.S. insurance companies issued 2 million online quotes for life insurance in 2009.[236]

Using the Internet for equity trading has contributed to the price of equity trading declining by as much as 90 percent.

Intuit's TurboTax software has revolutionized the tax preparation business by offering a CD-ROM and online software application with as much tax expertise as a typical tax accountant, but at a considerably lower price. Using e-filing software also yields more accurate tax returns for taxpayers; the error rate on tax returns submitted by paper is 20 percent, compared to an error rate of less than 1 percent for electronic returns.[237] In addition, because the private companies that make electronic filing software are competing intensely for market share, they have strong incentives to make their programs as easy to use and comprehensive as possible.

Home buyers and sellers can take advantage of self-service options offered by real estate companies to accomplish for themselves what they used to have to pay a real estate agent to do. Improved access to information also allows individuals to learn about properties without having to be physically present. Virtual tours of houses, for example, save prospective homebuyers hours on the road going from property to property by letting them first see inside a building before deciding if it is worth a trip to view the property in person.

Web sites like Zillow and Trulia provide potential buyers and sellers detailed property information, estimates of the value of a home, historical pricing data, and a list of comparable properties on the market. Companies like Zip Realty, an online real estate brokerage, use self-service technology to lower their operating costs and then share the cost-savings with clients. By giving their clients unrestricted online access to the Multiple Listing Service (MLS), relevant property information, and online tools to rate and review homes, prospective buyers can maximize the value of the time they spend with their agent. In return, after buying or selling a home, buyers receive a cash rebate equal to 20 percent of the real estate agent's commission and sellers pay a discounted commission to their broker. In addition, because homeowners now have access to the same information as real estate agents, some sellers forgo using an agent altogether, thereby allowing them to save the money it costs to pay a commission. To cater to these customers, Web sites such as ForSaleByOwner.com offer fee-for-service options to home buyers and sellers who would rather not use an agent at all. For example, sellers can pay a flat fee to list their property on the MLS, rather than paying a commission. Eighty-seven percent of those searching for a home in the United States use the Internet; as of 2008, 32 percent of home buyers first learned about the new home they purchased over the Internet.[238]

Consumers are even taking over the jobs of customer service representatives. For example, consumers can check online the progress of packages being handled by most major shipping companies.[239] By going online and doing the work themselves, consumers can often save time and money and companies can charge lower prices overall. Likewise, airline passengers in many countries have grown accustomed to selecting online their own seats for airline flights.

The Internet also makes it possible for individuals to become active producers in the economy. The phenomenon of peer production is increasing rapidly as users generate and consume content from each other, blurring the lines between producers and consumers. Among blogs, social networks, YouTube videos, and wikis, users are creating substantial additions to the Internet.[240] In Korea, OhmyNews relies on 33,000 volunteer reporters who submit articles to its staff of 35 who review and compile the articles into an online publication that has surged in recent years, even as more conventional media outlets have lost readership.[241] Similarly, CNN has launched iReport, an online service that empowers individuals to become citizen journalists and submit articles, photos, and video of news as it happens.

To be sure, the many benefits to empowered consumers might seem to be at the expense of accountants, attorneys, realtors, reporters, stockbrokers, travel agents, or others. And in some cases this is true. However, economies are not organized (or at least should not be) to preserve job security for certain professions, but rather to ensure that the overall population enjoys an increasing standard of living. And e-commerce is driving that growth. Moreover, in some cases e-commerce lets these jobs shift to more complex and valuable work. Many of these professionals, such as attorneys or insurance agents, are able to devote greater time to more complex matters where their expertise is more highly valued. For example, even as the public enjoys iReports at CNN's Web site, there remains value for news that is vetted, verified, and edited for accuracy. As this report explains, the dot-com economy has created new products and services in a variety of fields, many of which require technical skill and raise the value of professional expertise.

Holding Organizations Accountable for Providing Quality Goods and Services

By giving consumers more information about goods and services, the Internet puts competitive pressure on organizations to boost quality. For example, eBay's seller rating system allows buyers to rate eBay sellers on the quality of the service, enabling future buyers to avoid sellers with low ratings and spurring sellers to provide good service. Before the Internet, an organization providing poor service or shoddy products might go relatively undetected, because it was difficult for affected consumers to communicate their displeasure beyond their immediate circle of family and friends. Moreover, organizations had very little capability to determine whether their customers were satisfied. Now organizations can use low-cost, online surveys to more easily tease out customer preferences. Better customer information can help a business catch a poor decision before it causes long-lasting damage and also help businesses tailor their services more closely to their customers' wants and needs.

What's more, the Web gives consumers the power to check many different sources to benchmark quality, from the on-time performance of airlines, to test scores in elementary schools, to the quality of physicians (ratemd.com), college professors (ratemyprofessor.com), and competing universities.[242] Now, when consumers are unhappy, they can let the whole world know. For example, when an AOL customer tried to cancel his service, he recorded a telephone conversation that revealed AOL's determination to retain customers.[243] Audio of the exasperating incident was posted online and spread through blogs, leading AOL to alter its customer retention policies. Instances like these of customers actively informing businesses of their wants, needs, and qualms through the Internet will only increase going forward.

Expanding Consumer Choices

An economy that gives consumers more choices in products and services inherently provides more value to people than one that provides fewer choices for the simple reason that broader choices are more likely to better match the different interests and needs of more individuals.[244] The Internet plays a central role in creating an economy that gives consumers vastly more choice. In the same way that a large supermarket gives shoppers a wide variety of products to choose from, the commercial Internet has reduced the costs of giving consumers more choices, creating the "long tail" effect described previously. As Chris Anderson convincingly documented in his book *The Long Tail: Why the Future of Business is Selling Less of More*, the Internet economy has created marketplaces where it is economical for even the most obscure goods to be sold.[245]

Moreover, the Web enables sellers and producers who might otherwise never be known to find an audience, and conversely makes it possible for consumers to find products or experiences they might otherwise never find. For example, Clap Your Hands Say Yeah, a popular Indie band, has managed to sell over 100,000 copies of its self-released debut CD online without having a recording contract.[246]

THE INTERNET ECONOMY HELPS FIRMS AND WORKERS

The Internet economy not only helps consumers, it helps firms become more productive and profitable and helps workers earn higher wages and become more employable.

Boosting Productivity in Firms

Internet solutions help firms boost productivity and cut costs, thereby enabling them to cut prices and expand output. One way firms save money is that Internet solutions enable them to streamline their supply chain. Overall, the cost savings from global business use of e-commerce were estimated to have reached $1.25 trillion by just the mid-2000s.[247] (Global business-to-business e-commerce value was expected to have reached $4.3 trillion by 2005.)[248] Firms can achieve savings because e-business is significantly more efficient than regular transactions. For example, processing a purchase order manually costs 8 to 18 times what an online procurement costs.[249] This is one reason why firms utilizing e-procurement enjoy 7 percent higher value-added (the value of output produced compared to the costs of inputs) than firms that do not.[250] But even larger savings accrue to firms from creating Internet-enabled supply chains. The ability to track shipments online allows firms to better time production and to anticipate bottlenecks in supplies, while up-to-the-minute information about inventories tells suppliers when fresh deliveries are needed. Cisco Systems alone saves $360 million per year through using the Internet for e-business.[251] IBM, with over $91 billion dollars in annual revenue, was able to save $6 billion dollars in 2005 by reengineering its supply chain processes, which included the automation of some processes through Web-based applications in addition to other process changes and consolidation of functions. IBM established an e-procurement system which substantially improved efficiencies, reducing the average contract cycle time from 6 to 12 months to less than 30 days. IBM also established an Internet-based tool for booking employee travel in 2004 that initially posted average monthly savings of $2.5 million.

An array of studies document how the commercial Internet boosts firm productivity and profitability:

- One study, looking at the adoption of Internet-based business practices, found that between 1998 and 2001 firms in the United States saved $155 billion, and by 2010 they are expected to cumulatively save $528 billion.[252] The study estimated that the net impact of these cumulative cost savings is expected to account for 0.43 percentage points of the future increase in productivity growth.
- A review of 1,394 German firms found engaging in B2B e-commerce significantly increased both multifactor and labor productivity. The study found that firms that did not

use B2B e-commerce would increase their productivity if they used it. The authors stated, "Especially at the micro-level there is broad empirical evidence for positive impacts of ICT on labor productivity."[253]

- In a study of firms in the EU, firms that had implemented eight e-business practices (including online sales and purchasing) were more than twice as likely to report that they had increased productivity in the last year, and they were approximately twice as likely to have expanded employment compared with firms that did not use Internet technologies to innovate.[254]
- In a study of 1,955 European firms, Nurmilaakso found that Internet access and standardized data exchange with trading partners contributed to significant increases in labor productivity.[255]
- A study of over 6,000 firms in New Zealand found that the adoption of broadband Internet service boosts productivity by approximately 10 percent across all firms, with an even greater increase for firms in rural areas.[256]
- Evidence from a U.S. manufacturing sample shows that the use of LANs, EDI, and the Internet by a manufacturing firm increases labor productivity by 5 percent.[257]
- A Finnish study found that granting an employee Internet access at work increases his productivity by 3 percent in the service sector.[258]
- Studies examining Swedish firms found that access to broadband Internet is associated with increases in productivity of 3.6 percent for manufacturing and services firms[259] and 62 percent for ICT firms.[260]
- A study of the U.S. wholesale automobile industry found that adoption of B2B electronic commerce cut the costs of selling cars by 5 percent of the value of the automobile and 80 percent of the transaction cost.[261]
- Another study found that 34 percent of U.S. and 29 percent of Danish small manufacturers surveyed indicated that their competitive position was strengthened a great deal by doing business online.[262]
- A study of 253 small firms in Spain found that e-business solutions increased organizational performance by expanding industry learning and organizational efficiency.[263]
- A study of 1,666 SMEs in the United States, Canada, the United Kingdom, France, and Germany found that small firms adopting Internet business solutions enjoyed an increase in revenue of approximately 9 percent.[264] In addition, firms in the United States and Canada enjoyed decreased costs of goods sold by approximately 7 percent (European firms had lower decreases). Moreover, customer-focused Internet business solutions (e.g., e-commerce, e-marketing, etc.) were ranked as the primary drivers of increased revenues and reduced costs. As the authors conclude, "Our data show clearly that the adoption of Internet business solutions by SMEs in Europe and North America leads to tangible benefits."[265]

Internet-enabled firms are also able to pay higher wages:

- One study examined the relationship between business use of advanced Internet technology and U.S. wage growth between 1995 and 2000 and found that business use of advanced Internet technology is associated with wage growth.[266]
- A study of farm households in Taiwan found that Internet use improves farm household income.[267]
- A study of Internet users in the United States found that use of the Internet is associated with higher wage growth, in part because it imparts higher skill levels.[268]

Box 1: Nicholas Carr Was Wrong: IT Does Matter

Because so many product and service markets are highly competitive, most of the benefits of the dot-com economy usually flow through to consumers in the form of lower prices, higher quality products, and better service. This process is what Nicholas Carr was referring to when he claimed that "IT doesn't matter."[269] Carr acknowledged that IT mattered a great deal to the economy, but argued that since all firms have to use IT (not using it consigns them to a significant competitive disadvantage), it fails to give firms a distinctive advantage that they can use to achieve higher returns, especially over the longer term as the adoption of these technologies becomes ubiquitous. However, there is considerable evidence that IT matters not just to the entire economy, but to individual firms as well. The evidence suggests that Internet-enabled business practices not only lower prices (helping consumers and the economy) but also boost returns. Efendi, Kinney, and Smith found that firms adopting B2B procurement systems increased average return on assets by nearly 3 percentage points and raised their average profit margin by 2.7 percentage points relative to a matched set of non-adopting businesses.[270] Likewise, a comprehensive study of over 1,100 large U.S. firms conducted by one of the leading observers of IT and business, MIT Professor Erik Brynjolfsson, found that firms with higher profit rates were those that generally adopted what Brynjolfsson calls digital business practices (the adoption of IT and business practices that take advantage of them). In addition, as the authors of one study on the benefits of adoption of Internet-enabled business practices stated, "From our analysis, we can conclude that Carr got it wrong… IT does matter."[271] One reason why Carr got it wrong is that with Moore's law and continued innovation in IT, including in applications, IT technology is continually improving. Firms that stay on the leading edge of applying it can gain sustained advantage over their competitors that lag behind.

Giving Small Business Access to Larger Markets

Not long ago, businesses and consumers in big cities had considerable advantages over those in rural areas. Specialty stores could thrive with concentrated populations of diverse tastes. The Internet has changed this dynamic. Taking a business online gives companies a potential customer base 20 to 30 times larger than those enjoyed by stores in even the largest metropolitan areas.[272] As a result, consumers who live in smaller metropolitan areas or rural areas and who were previously constricted in their choice of products and services now have the same kinds of consumer options as someone living in Manhattan. As long as they have broadband Internet access, ranchers in the middle of Wyoming have the same selection of music and books through iTunes or Amazon as anyone in New York City. Even services once thought to be non-tradable, or impossible to export beyond immediate markets, such as health care and college education, are increasingly traded over the Internet and can reach even the most remote areas. Farm households are more likely to purchase a greater percentage of non-durable goods (e.g., books, clothes, etc.) through the Internet the farther away from urban markets they are.[273]

> Firms utilizing e-procurement enjoy 7 percent higher value-added than firms that do not, in part because processing a purchase order manually costs 8 to 18 times what an online procurement costs.

While the Internet has assisted many small businesses in realizing efficiencies and accessing new customers, it is also true that some e-commerce developments have led to small businesses losing market share. Since e-commerce gives consumers access to businesses around the world, not just in their local neighborhood, consumers may elect to purchase books from Amazon instead of a local bookstore or develop vacation packages online instead of through the local travel agent. Overall, the result has been lower prices and increased convenience for consumers, although this has contributed to some degree to fewer small firms selling books and travel services.[274]

Nevertheless, the Internet has enabled many small businesses to gain access to new markets, especially those businesses providing a unique product or service. A major reason for the ability of these small firms to thrive through e-business is that the Internet enables them to more easily access markets beyond their local area. This is particularly important for rural small businesses. Indeed, in what has been termed "Internetalization," the Internet gives firms access to customers around the world, as a number of studies have demonstrated. For example, Becky Collins, known as "Granny B," runs a successful business selling homemade pillowcase dresses from her rural hometown of Homer, Louisiana. With the help of her Web site, Collins is now a full-time entrepreneur, demonstrating the potential of e-commerce with the help of broadband Internet.[275]

One study of firms in Australia found that the "Internet has a positive influence on international information, knowledge, entrepreneurship, and networks and these in turn influence international market growth."[276] Likewise, a study of 438 Canadian SMEs in manufacturing found that those that are active in international markets are more inclined to conduct business electronically and make more extensive use of e-commerce than SMEs that are active only in local markets.[277] In particular, the study found that firms using e-commerce to support their international sales and marketing activities are likely to also use it to support their international procurement activities. These impacts appear to be widespread in many nations. One study that analyzed the impact of Internet penetration rates in 66 developing countries found that a 1 percent increase in the number of Internet users is associated with a 4.3 percent increase in exports.[278] E-business solutions also let firms more easily establish better relationships with suppliers, partners, and customers, regardless of where they are located. A study by Trimi, Faja, and Rhee found that the use of Internet-enabled solutions increased the frequency of new partnerships, improving the quality of relationships with existing partners and increasing partnership performance amongst 206 small U.S. firms.[279]

But the benefits of Internet-enabled business solutions are not confined to developed nations. Small businesses in developing nations benefit too. Sellers in developing countries can use the Internet to get access to market information that enables them to gain better terms of trade with wholesalers and other intermediaries and to make better decisions about what and when to produce. In 2001, for example, the villages and local governments of the Dhar district in central India joined together to fund the Gyandoot project to build a low-cost rural Intranet joining 20 village information kiosks.[280] This project enabled villagers in the district to share information and access the Internet using dial-up connectivity through local exchanges on optical fiber or ultra high-frequency radio links.[281] Farmers using the service went online and found a distant village that was willing to pay more for their potatoes than the local rate. As a result, the Gyandoot project has increased prices paid to village farmers by 3 percent to 5 percent and has saved the farmers from having to pay commissions to middlemen.[282]

The Indian Tea Board, the body responsible for the world's largest tea market, has created a similar initiative to use IT and the Internet to facilitate tea "spot trading." Tea has been traded in India since 1861 at the Tea Auction Center in Assam, where transactions were brokered in person and recorded on paper. In 2008, the tea markets went digital. The move to computerized tea auctions now allows buyers to bid from anywhere in the world. Studies in other commodity markets have shown that even modest reductions in transaction costs through automation can produce large increases in trading volume. The hope is that computerized spot trading will result in more efficient services and fairer prices for India's tea farmers.[283] Several studies have analyzed the effect of the Internet and IT on the efficiency of micro-businesses in the developing world, with one study finding that IT has substantial effects on Indian micro-firms by eliminating intermediaries between small firms and their customers, cutting prohibitively high transaction costs.[284]

Boosting Innovation

Innovation is the introduction of new products, services, and business models to the market. Innovation requires creativity, inspiration, and information. Knowing what users want, knowing what their needs are, and knowing how to develop new products and services is essential for innovation. The Internet helps with all of this. In the European Union, about one-quarter of firms surveyed state that the Internet enabled them to introduce new products or process technologies.[285] This included activities such as selling and purchasing online and engaging in e-learning. Moreover, Internet-enabled innovations boost firm sales and employment.

Increasingly companies are, in the words of MIT Professor Eric Von Hippel, "Democratizing Innovation."[286] Firms use the Internet to allow customers, partners, and third parties to co-create alongside them, helping them to design and develop new innovations. For example, kite surfing advocates created and now participate in a Web site that has turned into a major site for innovation in the field.[287] Dell launched its IdeaStorm Web site in 2007 to more easily solicit ideas and suggestions from its customers that could be integrated into the product development lifecycle. Using this Web site as a virtual suggestion box, online users can submit their feedback and vote for the best ideas. In turn, Dell tracks which ideas are submitted, reviewed, and implemented and provides more transparency to its customers on its initiatives and business decisions.

The Web is even being used to help companies solve complex technical problems. Perhaps the best examples of this are NineSigma.com and InnoCentive.com, which have created online portals in which problems posed by business are outsourced to the general community for a reward.[288] Over 200,000 "solvers" from 175 countries participate in InnoCentive's network. So far the largest reward for a solution is $1,000,000 and solutions have come from as far away as Russia, India, and China. One study of the economic impact to a corporation using InnoCentive challenges found it receiving a return on investment of 74 percent with a payback period of less than three months.[289] As another example, IBM leverages the Web to organize what it calls "Innovation Jams" to brainstorm new ideas. Held over a 90-hour period from October 5th to 9th 2008, IBM's 2008 Innovation Jam saw over 90,000 individuals from more than 1,000 companies across 20 industries make 32,000 posts.[290] Working closely with leaders from the participating Jam companies, IBM distills the thinking into a core set of the most promising ideas.

The Internet also helps organizations better manage the existing knowledge of their employees. For example, one specialty chemical company made over 2,400 technical case histories available for its employees worldwide to access.[291] Prior to the Web, it could take weeks for employees in dispersed divisions to find answers from experts in their own organization. But putting knowledge management systems online has changed that. For example, oil well equipment company Schlumberger used an online knowledge management system that reduced by 95 percent the time involved in resolving technical queries.

The Internet further facilitates innovation because it enables companies with new products and services to more easily find markets for them. In the old economy, firms that developed new products or services had to launch expensive marketing campaigns in order to make consumers aware of them, or had to work hard to get existing retailers to stock the new product. Now with the Internet and e-commerce, firms have an easier time introducing new products and services. Indeed, a study by Prince and Simon found that the Internet helps bolster demand for products early in their diffusion process, and that improved access to information and the convenience of online shopping are likely the primary drivers of this effect.[292]

The Internet isn't just about enabling high-tech innovation. One site, AfriGadget.com, is dedicated to showcasing African ingenuity. A team of bloggers and readers contribute their pictures, videos, and stories from around the continent. The stories of innovation are inspiring. They showcase simple, sustainable inventions in Africa, ranging from efforts to create biodiesel fuel out of local pine nuts in Sierra Leone, to programs to build bicycles out of bamboo in Ghana and Kenya, to low-cost parabolic solar reflectors in Somalia.

> Use of the Internet in the United States is associated with higher wage growth, in part because it imparts higher skill levels.

More Efficient Labor Markets

With average employment tenure lower than it was two decades ago, workers face more risk of losing their jobs, even when the economy is not in recession. In the old economy unemployed workers searched for jobs through means including social networks, employment agencies, and newspaper help wanted ads. But with the arrival of the Internet, Web sites such as CareerBuilder.com and Monster.com enable superior matching between employers and employees, making the process cheaper and faster and providing both employers and employees with more information on which to base their decisions. More than two-thirds of U.S. job seekers now search for jobs online, and the relatively low cost of finding and screening applicants means that higher quality matches are possible (which raises labor productivity as well).[293] A November 2006 study by the Conference Board, an economic research organization, found that 38 percent of job seekers who received offers felt that their job offer originated from their Internet search.[294] Workers who use the Internet for employment search are 15 percent more likely than non-users to have moved to a new job within a month, further suggesting that online searching leads to better job matching.[295] The Internet can also provide better opportunities for particular kinds of workers. In one study of highly skilled immigrants to Canada, researchers found that by using the Internet (instead of social networks or employment agencies) immigrants received better signals about the job market while also sending better signals to potential employers, thus enabling them to find more and better opportunities to get good jobs.[296]

The Internet has also been central to the emergence of telework as a viable option for many jobs. Using dot-com technology including Web mail, video conferencing, and other Internet applications, more workers are able to work from home or satellite offices.[297] This enables employers to offer more flexible work arrangements and helps retain talented workers. For example, doctors can take calls from patients and use a Web site to submit an e-prescription. Companies like JetBlue have eliminated call center locations entirely by replacing them with work-from-home staff connected via the Internet to JetBlue's central reservations system.

The Internet enables more efficient allocation for a wide variety of products and services, helping to maximize the economy's allocative efficiency by distributing products, services, and skills to the parties that value them most highly.

The Internet also enables businesses to more easily take advantage of larger and more competitive labor markets. For example, by using the Web sites CrowdSpring.com or Freelance.com a business can advertise a creative project and then choose the best submission to their project from designers all over the world. The availability of low-cost, high-quality online communication and project management tools makes it easy for workers to collaborate with other teammates located anywhere in the world.

Not only has the digital economy enabled more people to work in the paid, market economy, it has enabled more people to contribute through volunteer efforts, which help the economy grow by expanding overall economic output. In the wake of Robert Putnam's 2000 book, *Bowling Alone*, there has been considerable concern that Americans are participating less in civic activities. Yet, while perhaps not making up for the loss of face-to-face volunteering, the Web, particularly since the emergence of the more social Web 2.0, has made it easier for people to volunteer online and to find volunteer opportunities in their community. One study estimates that between 10 and 15 million people worldwide participate in online volunteer communities, ranging from online volunteer technical support groups (more than 50,000 of them) that win industry awards for their quality support, to volunteer mentoring and tutoring programs that give career advice and even provide matching services between individuals considering a field and experts already in it.[298]

The Internet can also play a particularly important role in helping retirees plug into volunteer opportunities. As baby boomers retire in droves, tapping into their talents will help ease the loss to the economy their retirements would otherwise bring. Sites such as Dinosaur-exchange.com are springing up to connect retired professionals who are not content to spend the next couple decades playing shuffleboard with potential employers desperate for expertise.[299] YourEncore.com connects the technology and product development opportunities of member companies with the talents of retired scientists and engineers.[300] Instead of bringing in untested outside talent, retirees serve as a safe and flexible workforce and these sites keep that pool of talented workers in close contact with potentially undermanned companies in case a contract or salary position is needed on relatively short notice.

More Efficient Allocation of Goods and Services

The Internet enables more efficient allocation for a wide variety of products and services, helping to maximize the economy's allocative efficiency by distributing products, services, and skills to the parties that value them most highly. For example, the Internet has spurred creation of auction and matching markets for everything from personal memorabilia to commodities markets to professional skills. The Internet also allows money to be allocated more efficiently. By speeding transactions, e-payments reduce the need for companies to hold working capital caused by the delay in processing checks, so that more economic activity can be associated with the same money supply.[301]

At the consumer level, online companies like Craigslist enable markets for things like apartment rentals to operate more efficiently. Originating in San Francisco, Craigslist allows users to post classifieds for everything from apartments to jobs to personals at greatly reduced prices relative to conventional means. Not only does Craigslist save listers money, it causes a significant reduction in the apartment and housing rental vacancy rates because it does a better job of linking renters with landlords.[302]

The Internet also makes it easier for organizations and individuals to participate in markets, particularly by linking individuals with products that others may not find of much value. There is no better example of this than eBay. For those sellers who use eBay to sell used goods, this does not lead to more production, but it does lead to more value because it enables items to be reallocated from individuals or businesses who value them less to individuals and businesses who value them more. What once might have been thrown out (or stored in an attic) in the old economy is now used and provides value to someone else in the new economy. Likewise, services like Amazon.com's used book service make it just as easy to buy a used book as a new book and to find out-of-print books, better allocating books that otherwise would have been thrown away or left in an attic. Without the Internet, this kind of reallocation was confined to weekend swap meets, garage sales, or other haphazard and time consuming exchange mechanisms.

The Internet doesn't just enable workers to be more productive, it also lets organizations use capital equipment and natural resources more efficiently (as the trucking industry's use of the Internet, described previously, illustrates.) In any organization capital is a scare resource, and its more efficient use frees up that capital for more effective uses elsewhere in the organization or in the economy as a whole. But capital equipment only contributes to output if it is used, and in many organizations equipment is underutilized. By helping to match demand and supply, the Internet can play a key role in enabling organizations to increase utilization rates of capital equipment.

Likewise, the Internet lets airlines better schedule flights and raise seat utilization, allowing them to operate fewer flights, saving fuel and money. This is particularly important in ensuring that scheduled departures are as full as possible; airlines receive no revenue from empty seats. Now airlines can advertise and sell e-fares online one or two weeks before a flight departs, filling up otherwise under-booked flights with customers willing to fly with flexible schedules and pay lower prices.

Many of the benefits of the commercial Internet remain under-reported; for example, the total value that consumers get from Internet searches is not counted in any official output statistics.

THE DIRECT CONTRIBUTION OF THE INTERNET INDUSTRY TO THE ECONOMY

While the lion's share of the value of the commercial Internet lies in the social and economic benefits it confers to the global economy, the Internet itself constitutes a noticeable component of the U.S. economy. Defining and measuring the value of the Internet industry itself is not easy, as there is no clear, agreed-upon definition, and data availability is limited. However, there are some estimates.

Globally, the OECD estimates that of the top 250 ICT firms in terms of revenue, Internet firms accounted for $18.3 billion in revenue in 2000, growing to $56 billion in revenue in 2006, with employment growing from 47,539 to 93,380 over that time period.[303] However, these numbers significantly undercount total employment, as they only count employment in Internet firms and not in firms that provide Internet services as part of their overall business (e.g., Microsoft) or in firms that use the Internet (e.g., the jobs of those managing Web sites or Web services for corporations). Globally, the Internet industry is still an American-dominated one. Of the top ten Internet firms in terms of revenue, nine are American, with one being an affiliate of a U.S. company (Yahoo! Japan). The largest dot-com firm in terms of employment is Amazon, while the largest in terms of revenue is Google.[304]

Within the United States, using a broader definition of Internet employment, a study commissioned by the Interactive Advertising Bureau found that 1.2 million Americans are employed directly to conduct Internet advertising and commerce, build and maintain the Internet infrastructure, and facilitate its use. Each Internet job supports approximately 1.54 additional jobs elsewhere in the economy, for a total of 3.05 million jobs, or roughly 2 percent of employed Americans. The dollar value of their wages totals approximately $300 billion, or around 2 percent of U.S. GDP.[305]

Given that many Web sites are free to visit, one of the key sources of revenue to the Internet industry is advertising revenue. While globally television and newspaper advertising still dominates, Internet advertising has been growing the fastest as a share of advertising, increasing from around 5 percent of all advertising in 2005, to almost 10 percent in 2009, with almost all of that share coming at the expense of newspapers and magazines.[306] In 2007, overall global online advertising was estimated at $31 billion. The nations that lead in online advertising as a share of total advertising are the United Kingdom, Norway, Sweden, and Korea, with levels of more than 10 percent of total advertising expenditures.[307] Within the United States, Internet advertising amounts to $20 billion in revenue.[308]

Finally, dot-com domain names themselves often have significant value. At first, many companies were slow to realize this, which often allowed individuals to buy up what they thought would be valuable domain names and later sell them to companies at considerable profit. In fact, as late as 1994 only one-third of the Fortune 500 had registered an obvious version of their domain name online.[309] For example, in 1994 cbs.com was registered to a consultant in Golden Valley, Minnesota. Only later did CBS determine that it really needed to own this domain name. Consequently, some domains have sold for considerable sums of money. The dot-com domain name that sold for the most money is Fund.com, a site that helps users find mutual funds, which was purchased for almost $10 million ($9,999,950). In fact, at least 40 dot-com names have been purchased for prices of at least $1.5 million.[310]

Doctor accessing patient's electronic health record

While the Internet economy has and continues to transform business and the economy, it is also transforming society and individual life. In fact, the Internet has been a key enabler of many of today's key innovations and improvements in our lives and society—from better education and health care, to a cleaner and more energy-efficient environment, to safer and more secure communities and nations.

EXPANDING INFORMATION AVAILABILITY AND ACCESS

One of the most important impacts of the commercial Internet is making individuals' access to information more convenient and efficient. The Internet contains all kinds of information that touch every part of modern life. New technologies are making all that information easier to find and verify while also expanding the opportunities to interact with, contribute to, and view all sorts of information.

Growth of Information Online

Throughout the 20th century, most information was passively received through TV, radio, newspapers, and magazines. Finding information meant searching through whatever books sat on a bookshelf or in the local library. These traditional publishing paradigms restricted the creation of new information sources and access to information. But the paradigm has shifted dramatically over the last 20 years as books have given way to Web sites and new sources of information have flooded the Internet.

With a few strokes on a computer keyboard, Internet users can learn about a foreign destination they wish to travel to, find reviews about local restaurants, or discover the best neighborhood bicycle routes. Indeed, while it is hard to imagine living without the Internet now, not too long ago if one wanted to learn about Mozart, driving to the local library was often the only option. Now with search engines like Google and online encyclopedias like Wikipedia, volumes on virtually any subject are but a click away. In education, students are no longer limited by the walls of a library or the expertise of a single teacher because they can access resources from a global classroom and connect with both fellow learners and subject matter experts, regardless of geographic proximity. In health care, patients can study their conditions using the same materials as their doctors, share insights with people suffering from similar maladies, and get additional opinions on how to proceed with various treatments. The impact of the Internet on improving individuals' lives through improving their access to information has been profound, making daily activities more efficient and robust.

One of the most striking aspects of the IT revolution is how it enables new sources of information to be created by lowering the barriers of publishing to allow anyone to contribute to the Internet's collective knowledge base. Blogs have become platforms for individuals to have their voices heard. Though some blogs do not deal with matters of substance, many are being written by subject matter experts, be they professional or amateur, sharing their insights on trends, commenting on news, and providing free analysis and new perspectives that previously might never have found the light of day. Blogs provide an opportunity to find the unfiltered opinions of people around the world, from consumers to innovators, and they are now often being used by industry as well to announce new products, services, and hires in a less structured and often more informative way than a press release.

Tapping the collective wisdom of the crowd to compile more comprehensive sources of information is the defining characteristic of a "wiki," a Web site that allows users to contribute by adding or modifying content. The most prominent example is Wikipedia.org, an online encyclopedia created and updated by its users. But wikis are also increasingly being used inside corporations, schools, and government agencies in order to create a public or private knowledge base to help the organization run more efficiently. A number of sites have sprung up that allow anyone to pose questions to subject matter experts and receive specific answers. One such site is AllExperts.com, which features a host of volunteer experts ready to answer questions on topics ranging from how to create great animation to computational biology to tips for dealing with chronic pain. Simply select an expert, pose a question, and receive an answer. Combining the ability to ask questions of experts with the power of the collective consciousness are sites like Yahoo! Answers, where questions can be posed to an open, global audience of potential experts. Anyone can answer and anyone reading the question can weigh in on which answer is their favorite, helping a user determine which answers to trust. User input helps direct people to new information and engage in better decision making. User reviews help online shoppers decide which product to buy and which merchant to trust. Home chefs can search through online recipes and choose dishes with the best ratings and find the most useful tips. Users can even go online to Zeer.com to find the nutritional labels of a wide array of foods and to see how other users have rated the food.

Another tool that helps users automatically receive content is RSS, short for Really Simple Syndication. Using RSS, users can subscribe to a Web site and receive updates when new information is posted on that site. Subscribing to an RSS feed is like subscribing to get a magazine delivered to the home rather than having to go to the store to buy it. RSS readers also allow users to create custom searches that will alert the user when it finds new content that matches their interests. In this way, users can have relevant information find them rather than them having to go out and find it. Businesses use this same model to create a digital memo system that automatically notifies relevant parties when information such as company policy changes. RSS is not limited to Web pages because it can also be used to enable multimedia feeds. The most common type of multimedia feeds are podcasts, which are typically recorded Internet radio shows. Users can download podcasts on thousands of topics—from learning to speak a foreign language to university lectures to congressional hearings. Users can even set up a program like iTunes not only to download podcasts automatically but also to synchronize them with a portable media player, meaning the content is ready for them to listen to within moments of becoming available. Although podcasting got off to a slow start, from June 2007 to March 2008 the percentage of global Internet users who downloaded podcasts more than doubled, from just over 20 percent to 45 percent.[311]

The Internet doesn't just provide information in the form of words; it increasingly serves as a source of information about places and geography. Thanks to the Internet, a vast amount of information is available to anyone contemplating a trip of any length from a walk to the corner store (is it open at this hour?), to a drive or bus trip across town (how is traffic?) or across the country (how far is it and what is the shortest, or most scenic, or least congested route?). Want to know what a road in Yosemite National Park looks like? MapJack.com will let you see it. Want to see what a view of a particular street is? Google Street View or Microsoft's Live Search Maps will show you. Want to find the best place for your next run and how many miles it is? Mapmyrun.com, can help you find out. Want to find the location of a restaurant? Individuals can go to Google Maps, MapQuest, or other online mapping systems and type in a specific location and the mapping application will then find and identify services (e.g., gas stations, restaurants, hotels) nearby.

The Internet has enabled the growth of over 100,000 new organizations focused on social issues.

Increasingly this kind of information is available in real time. Checking the status of a flight to see if it is on time or has been canceled is easily accomplished by mobile phone or Web browser. Both Google and Microsoft now have systems announced or already available that provide traffic information in real time. Google Maps provides a "traffic" button on its maps in metropolitan areas that shows red-yellow-green indicators for traffic speeds. And Google recently introduced a feature that reports "normal" traffic levels by the time of day or day of the week. Microsoft has announced a new software feature called Clearflow that uses artificial intelligence to provide navigation advice that takes into account expected traffic conditions on a roadway-by-roadway basis.[312]

The Internet has created a paradigm shift that benefits people with disabilities. Information is no longer constrained to a single medium. Instead, IT has created a world where users can choose the format in which they want to access information. Twenty years ago, for example, only a paper copy of the *New York Times* was available. Now individuals can choose to read the newspaper in print, online, or on a cell phone or other mobile device. Visually impaired subscribers can use text-to-voice applications to hear the newspaper and subscribe to podcasts from leading *New York Times* columnists.

Increasing Access to Health Information

Ever since Hippocrates developed an oath for doctors, the model of health care has been one where the doctor had the information and the patient received it. But this model was always flawed because it failed to make patients active participants in their care and treatment. One reason that some individuals are not more actively involved in managing their own health and health care is that they have bought into the idea of the doctor as the expert, believing that "the doctor always knows best." (Also, many have reported that doctors may berate them for inquiring about a remedy or trying to become a more active participant.) Now the Internet is fostering a radical transformation of health care by enabling patients to become much more empowered, both about the kinds of treatments that are available to them and about the quality of the health care providers they choose. By providing patients with access to more and better information, the Internet empowers them to make more informed health care decisions. By increasing patients' access to their own medical records and to a plethora of information to help patients make better decisions, the Internet has the potential to improve health care.

When patients have access to their personal medical records, they can take a more active role in their health care and routinely monitor their symptoms and treatment. Access to personal health records helps give patients a stronger sense that they have control of and responsibility for their own care. Many dot-com applications, including WebMD.com, revolutionhealth.com, health.com, and Microsoft's healthvault.com, have emerged to allow individuals to track and analyze their personal health information. With online access to their personal health records and new Web-based tools, individuals can manage their health information online as easily as they manage their finances. Currently, for example, online applications allow patients to track health markers such as their blood pressure, cholesterol, and body mass index to see how these indicators change over time and how they compare to healthy patients of the same age and sex. Patients can combine these online tools with medical home monitoring devices to track and compare their health between office visits.

Consumer demand for electronic health records (EHRs) and personal health records is growing, and many people have embraced the technology when it is available. One leading EHR software company reports that its product is used by more than 58 million people, mostly in large multispecialty practices.[313] The global leaders in the adoption and use of EHR systems by primary care physicians are Sweden, Finland, the Netherlands, and Denmark, where EHRs are used, respectively, by 100 percent, 99 percent, 98 percent, and 95 percent of primary care physicians. Two other countries leading the adoption of EHR systems by primary care physicians include New Zealand and the United Kingdom, with both posting EHR adoption rates among primary care physicians of close to 90 percent.[314] In the United States, Kaiser Permanente, the largest not-for-profit health plan in the country, has implemented an EHR system, healthconnectsystems.com, which allows patients and providers instant access to their medical information. Physicians use the system to place orders, review laboratory results, and access their patients' medical histories. Health plan members access the information using a secure Web portal that allows them to review laboratory results and office visits, as well as to communicate with their providers. As of mid-2007, 1.4 million Kaiser Permanente members had signed up for online access.[315] Kaiser Permanente has also partnered with Microsoft to allow its members to voluntarily manage their personal health records using Microsoft HealthVault.

Some health systems that have introduced EHRs have found that they help reduce health care costs associated with visits to physicians. One study found that after introducing EHRs, Kaiser Permanente reduced visits to primary and specialist outpatient care by 5 to 9 percent.[316] Another study found that annual adult primary care visits decreased between 7 to 10 percent among patients who communicated with their providers electronically.[317] Secure Web portals also automate and simplify many health care transactions for the patient, including booking doctors' appointments, making copayments, filing for insurance reimbursements, and ordering prescription refills. In addition to EHRs and personal health records, other online tools also increase access to health information. Today, patients use health resources on the Internet to learn more about medical conditions, treatments, and prevention. Indeed, a survey in 2005 found that 80 percent of U.S. Internet users have searched for health information online.[318] Online health resources eliminate barriers to information by giving patients more convenience and privacy, access to online social networks, and the ability to communicate with specialists around the world.

Online Education

Given the vast array of information Web sites enable, it is not surprising that the Internet has led to an explosion of online learning. Flexible online classes give people access to education in ways that would never have been possible before the Internet arrived.

These applications can start from the earliest years of life. Fisher-Price, for example, makes online games for babies and toddlers available for free, including games that help toddlers learn letters, numbers, names of animals, sounds of musical instruments, and other things.[319] Web sites such as FunBrain.com offer children online games and activities that reinforce skills and subjects taught in schools. Other online resources, such as Enchanted Learning, use multimedia to engage children's creativity to teach about nursery rhymes, inventors, music, and other subjects. TumbleReadables.com provides a series of online books that allow children to read along with the story and get help with words that are difficult for them.

Educators can find many useful resources on the Internet too. The Web site Curriki, for example, provides a platform for educators to design and share curricula that benefit students and teachers around the world. Similarly, Web sites like TeachingBooks.net provide teachers and parents learning guides and activities for popular children's books as well as online videos of authors and illustrators of children's books to encourage children to read.

Companies are also using the Internet to help train their employees. Among a sample of Fortune 500 companies and large public sector organizations, technology was used to deliver 37 percent of formal training in 2005, up from 24 percent in 2003.[320] For example, IBM's "Basic Blue" manager training program couples Web modules and simulation management exercises with classroom learning to achieve impressive efficiency gains: Studies have shown that the program costs one-third as much as a traditional classroom approach and managers learn five times the amount of material.[321] Recently, firms have begun to embrace a variety of new tools, including those that allow for peer-to-peer learning among coworkers. Indeed, blogs, wikis, podcasts, and collaborative software are becoming important tools for employees to exchange ideas and share insights.[322] IBM's WikiCentral, for example, has grown to include more than 12,000 users since its launch in 2005.[323] Though the initial expense to establish online learning programs can be high, companies save over time on course materials, employee travel, and instructor fees. As a result, the savings for online programs generally add up to about 50 percent.

By allowing the widespread production, transmission, and consumption of virtual products—replacing bits for atoms—the Internet is paving the way to a more sustainable society.

IT is also reshaping how adults outside of organizations learn. The growing phenomenon of online learning is one of the more important ways that technology is reinventing education. In online classes, educators deliver lectures or other educational content via Internet video or podcasts, which students with a broadband connection can often experience at a time of their own choosing. Some classes even take advantage of messaging software to incorporate discussions, either as asynchronous posts or real-time discussion forums or chat rooms. And with the proliferation of institutions like the University of Phoenix, online learning is growing rapidly. In fact, more than 3.2 million students took online higher education courses in the fall of 2005—an increase of 35 percent over the previous year.[324] Online education has become popular for a variety of reasons. A major reason is that it powerfully expands educational opportunities for people who may be physically unable to attend an educational institution because they are busy with work or children, are disabled or incarcerated, or live in a rural area where the courses they want to take are unavailable.

Distance education is moving in a direction that allows for greater interaction with other students. New online social software from companies like Writeboard.com and InstaColl.com allows students to engage in virtual collaboration on group projects for which they can collectively write and revise documents over the Internet. Similarly, online classes are increasingly taking advantage of blogs, wikis, podcasts, and streaming media to increase collaboration and interaction between students.[325] Even in-person classrooms are using these tools. For example, Blackboard Inc. empowers collaboration among students and professors between class meetings.

Finally, online learning is not limited to the content available in formal classes. The Internet puts an unprecedented amount of information at everyone's fingertips. With an Internet connection and a healthy dose of self-motivation, anyone can learn about a range of topics. These include topics related to activities of daily living—for example, it takes only a few clicks to find a Web video demonstrating how one can reset a Palm Treo smartphone (of particular use to visual learners who might have trouble with owner's manuals). Users wanting to find a wealth of "how-to" videos can go to Howcast.com to find everything from videos explaining how to make nachos to how to explain American football to foreigners. The Internet also includes more academic learning opportunities such as "iTunes-U," Apple's clearinghouse for free lecture podcasts from leading universities.

Building Community

The Internet has shepherded in a new era of online communities that supplement those found in the physical world. The Internet enhances existing communities and fosters civic activity by bringing people together and allowing them to stay connected.[326]

One way dot-coms do this is by creating new ways for individuals to find each other. Web sites such as Facebook.com and Classmates.com help reconnect old friends, helping people stay connected regardless of geography. For example, one study of 100 Facebook users found that only one was not "friends" with an international user, and as a group, study participants had over 1,500 foreign friends from all seven continents. Parents join Web sites to find others in their neighborhood who can share their experience with local doctors, schools, and job issues. Homeowners' associations can use services from LifeAt.com to create an online social network Web site for individuals living in their residential community. Using the LifeAt.com Web site, for example, neighbors can meet, organize activities, and showcase the community to potential buyers and rate neighborhood businesses. In addition, Web sites such as craigslist—the Internet's largest listing of local classified ads, job postings, personal ads, events and other announcements—provide custom portals for cities around the world that help residents find anything from a dog to a date. Many Web sites blend social networking features with another purpose. The Web sites Yelp.com and InsiderPages.com, for example, allow Internet users to rate local businesses and find others who share their opinion. The investments that people make in these online interactions yield positive benefits by creating a more connected and aware community.

Another way the Internet helps build communities is through online dating. In the United States, over 16 million people (or 11 percent of Internet-using adults) have visited an online dating Web site.[327] Web sites such as Match.com or Yahoo! Personals allow millions of Internet users to search through profiles of other users looking to date. Many specialized dating services have also cropped up that target an interest such as politics, the environment or sports, or a specific demographic, such as JDate.com for Jewish singles or PlanetEarthSingles.com for eco-friendly daters. Online dating Web sites allow users to search for the person who best fits their criteria to find the perfect mate rather than waiting for a chance encounter, and many singles use these Web sites for their efficiency. Looking for a more canine-oriented love? Petfinder.com lets users select from more than a quarter of a million animals, searchable by age, location, and gender.

Over 150,000 videos, totaling more than 30,000 hours of footage, are posted to YouTube each day, with YouTube now streaming 1.2 billion videos a day worldwide.

Tools to better manage the growing number of relationships of Internet users are also made possible by the Internet. Want to throw a party? Use sites like Evite.com and Mobaganda.com to send invitations and keep track of replies online. To keep track of people online, social networking Web sites such as Facebook.com and MySpace.com allow users to share personal information about their lives, develop new relationships with others, and stay current on the activities of their friends. Other networking tools such as LinkedIn.com give users the opportunity to network online and expand their professional network using their existing connections. Social networking tools can have a substantial impact on users. Researchers have found that individuals use social networking, e-mail, and other forms of Web-based communication to build, maintain, and enhance relationships and grow their social capital. Individuals then use this social capital when they need assistance, such as finding a job or getting financial advice.[328]

An additional community benefit made possible by using Internet-enabled social networking tools is the expanded availability of social (or peer-to-peer) lending. Social lending allows individuals to go outside of traditional lending institutions and borrow money from family, friends, or other members of their community. Online services such as VirginMoney.com allow borrowers and lenders to easily establish rates, terms, and documentation for personal, business, or real estate loans. Often borrowers can negotiate better rates and terms than they would get from a traditional lending institution, and lenders can receive better interest rates. In addition, family members can provide more generous loan terms and adjust the loan schedule or forgive payments if necessary. Another online lending service, Prosper.com, goes a step further and creates a marketplace where lenders essentially bid on loans requested by borrowers; rather than just listing a borrower's credit score and loan terms, this site allows potential lenders to view a borrower's personal statement, endorsements from friends, and group affiliations. In addition, each loan can be serviced by multiple lenders, so lenders can diversify their risk.[329] A similar online lending service, Zopa.com, which operates in the United Kingdom, Italy, Japan, and the United States, offers unsecured personal loans to borrowers with good credit. Unlike Prosper, Zopa underwrites all of its loans and investors' funds are guaranteed and insured by a partner credit union. Investors choose which borrowers to help and can increase their assistance by choosing a lower interest rate.[330]

Organizations both large and small can use the Internet to facilitate communication with their members. The Internet encourages peer-to-peer communication on both large and small scales. This phenomenon can be seen in the American political system with decentralized Web sites such as DailyKos.com fostering a community-based political dialogue.[331] Similar Web sites such as RedState.com and Townhall.com appeal to those on the right in American politics. In addition, Web sites such as Meetup.com encourage an active civic life by connecting individuals with others who share their common interests. Over 2 million people around the world have used the service to find local groups ranging from political organizations to foreign language clubs.[332]

Many organizations also rely heavily on the Internet for online fundraising. Since Howard Dean first demonstrated the fundraising potential of the Internet in the U.S. presidential primaries of 2004, major and minor political candidates alike have used the Internet to raise millions of dollars. Many tools are available online to help individuals raise funds for their charitable causes. The Web site Active.com offers a variety of tools to organize and fundraise for a charity sporting event. Marathon runners, for example, can form teams, recruit additional members, solicit and track donations, and receive and publish their fundraising and athletic results.

Non-profit organizations also use online tools to track volunteer contact information, skill sets, and performance. Web services such as WhenToHelp.com, available for free to nonprofit organizations, automate volunteer scheduling and let volunteers specify their availability and trade shifts online. A similar product, Count Me In, automates registration and league management for youth sports leagues. These types of tools help make civil society more efficient and allow citizens to more actively participate in their community. Moreover, many of these Web sites not only provide online tools to promote civic action but also develop their own online community. Active.com provides community message boards, blogs, and individual and team profiles where members can share training plans, seek and give advice, and share their stories or success. In addition to improving real-world communities, these Web sites are building new virtual communities of their own. Thus, it's not surprising that the Internet also has enabled the growth of over 100,000 new organizations focused on social issues.[333]

As the Internet becomes more of a tool for watchdog groups to scrutinize the behavior of firms, companies are going to greater lengths to prove, in depth, their socially responsible qualifications. Starbucks, for example, has an entire section of its Web site promoting its partnership with organizations like Save the Children and the American Wildlife Foundation, and it has published on its site a corporate social responsibility report annually since 2001.[334] The Gap also touts its corporate social responsibility credentials on its Web site and has undertaken an aggressive campaign to showcase its involvement with the RED campaign (dedicated to fighting AIDS in Africa). Since "hiding" bad behavior is much more difficult in the information age, a growing share of corporations are using transparency to build trust in the eyes of stakeholders and to develop a better dialogue with nongovernmental organizations that monitor activities such as unfair labor practices or environmental standards.[335] One corporation, Vodafone, which was ranked as the number one socially responsible company in 2006 by *Fortune*, has a "CR Dialog" page on its corporate social responsibility Web page that links conversations between experts, stockholders, and other interested parties about what actions the cell phone industry can take to become more socially responsible. Vodafone also has a section highlighting third-party audits of the company's behavior.[336] BP, ranked the number two socially responsible company, has on its Web site a list of socially relevant topics, such as human rights, natural disasters, and HIV, with links to in-depth policy reports, case studies, performance reviews, and future program plans, along with feedback options so users can feel like they are interacting with the company.[337]

Corporate social responsibility is moving beyond a marketing campaign to an authentic effort reflected in firms' business models. The accessibility of corporate information is creating a "race to the top" over which companies can perform the best. Although corporate social responsibility in the past was seen as a necessary cost for corporations, a recent report by IBM demonstrated that two-thirds of the business leaders surveyed used corporate social responsibility as an opportunity for financial gain.[338] *Fortune* reported in 2006 that $1 out of every $10 of assets under management was being invested in firms with high ranks on corporate social responsibility scales.[339] The Internet not only is helping to create transparency that reduces harmful business practices but is also allowing corporations to reap the goodwill generated from their good deeds. This goodwill, in turn, creates a stronger partnership between customers and companies, as well as better avenues for companies' growth.

The Internet is also helping to create global communities. For example, a significant source of capital for the developing world comes from money sent from migrants back to their home country. Transfers of money from foreign workers to their home countries—called remittances—constitute the second largest financial inflow into developing countries, dwarfing international aid.[340] A recent study found that in 2006 global remittances totaled three times that of aid provided by donor nations to the developing world.[341] IT is helping to make expatriate aid more successful by connecting potential donors with those in need. The Web site Mukuru.com, for example, allows members of Zimbabwe's diasporas to buy goods such as food and gas over the Internet for family members back home. The site has 10,000 clients so far and intends to expand to serve a half dozen more countries next year.[342] In the past, there have been high transaction costs for remittances due to diffuse and decentralized payment methods and the lack of information provided to migrant workers. Immigrants also use Web sites and online tools to maintain strong links to their hometown and maintain their local identity.[343]

Offering More Entertainment Choices

For many years, consumers have had only a handful of entertainment choices. Before cable TV, most consumers had a choice of just a few TV channels, assuming they were even close enough to a TV broadcast to get reception. Before the Internet, consumers could get only the books and music that their local store sold. The digital revolution has led to an explosion of entertainment choices—and it is not too unrealistic to postulate that at some point in the future people will have access online to virtually every song, video, book, and photo ever published.

The place where the expansion in entertainment choices is really playing out is the Internet. Indeed, the variety of video, audio, books, photos, and other entertainment now available online is breathtaking. Beyond opening up entertainment content in people's home countries, the Internet is making domestic entertainment content available internationally. For example, people can listen to Internet radio stations from around the world to hear news and information from abroad or to enjoy cultural or entertainment programming from distant countries. Movies can be purchased online for viewing. Although there are still some limitations in terms of what movies are available on what terms (e.g., rental versus retail), there is no limit to the number of titles and types of business models that can be implemented online.

To see the online entertainment choices available now to consumers, it is worth looking at what is happening in sports broadcasting. In the past, sports fans wanting to watch a game of their favorite team had to hope it was broadcast on their local TV, an unlikely event if their favorite team was not the team in their local media market. Now the Internet is giving people vastly increased choices in the sports events they can watch. In the United States, all the major sports networks, at a minimum, deliver clips of game highlights online; and most sports networks offer free and paid packages for people who want to watch entire events live and on-demand, with coverage that far outstrips that which is available on TV. During the NCAA (National Collegiate Athletic Association) basketball playoffs, for example, CBS streams live video of all the games online, while the local TV affiliate shows only one game at a time. The expansion of options in sports broadcasting is not limited to domestic sports either. The Internet opens up the world's arenas to anyone interested in sports who does not get mainstream coverage in their home country. Take soccer or cricket, two sports with huge international followings. Fans of soccer or cricket who do not get coverage in their home country can pay a monthly fee and start watching the games and matches over the Internet so they do not have to miss out. The Internet thus opens up a range of new opportunities for broadcasters and content generators to monetize the distribution of their sporting content.

The Internet is opening up a wide array of entertainment choices that previously could only be viewed or heard live by the people who were present. Indeed, the biggest Internet video success story to date has been the video-sharing site YouTube, which hosts user-submitted content. YouTube and Web sites like it allow anyone to upload a video and share it with the world. By drawing upon the "power of the crowd," these sites host deep and diverse libraries that feature everything from funny home movies to news and TV clips to video diaries to professionally produced original shows. Such sharing is what allows for the viral growth some videos achieve. A few people see a particular video and like it; they share it either privately with some friends or publicly on a different Web site; and then more people continue to see and share the video with others in their social networks. Over 150,000 videos (totaling more than 30,000 hours of footage) are posted to YouTube each day.[344] Moreover, YouTube now streams 1.2 billion videos a day worldwide.[345] In 2009, YouTube accounted for more than one-quarter (26 percent) of total time spent viewing video by all Internet users, more than the combined time spent of video content sites ranked between #2 and #25 (22 percent). However, the majority of online video viewing (52 percent) occurred at video sites ranked outside of the top 25, suggesting the increased fragmentation of online video and the emergence of sites in the "long tail."[346]

The energy involved in selling $100 of books is 14 times greater at a retail store than an online bookseller.

As an example of the viral spread of video clips over the Internet, a classic example is the amazing juggling performance Chris Bliss gave with the Beatles "Golden Slumbers" at a 2002 comedy festival, seen live by perhaps a few hundred people. The video clip remained a largely unnoticed posting on Bliss's personal Web site until early 2006, when someone came across it and sent it to a group of friends. The video quickly became an Internet sensation and, thanks to the wonders of viral marketing, was viewed over 20 million times by mid-April 2006.

Not only has the range of video choices on the Internet exploded; the number of audio choices on the Internet has also grown tremendously. It used to be that radio listeners were limited to the stations their antenna could pick up. Now through Internet radio, listeners can tune in to online versions of over-the-air radio stations from around the world that also stream live over the Web, as well as from thousands of online-only radio stations that can be created by anyone with enough passion for music. Likewise, it used to be that music CDs listeners purchased were limited by what CDs were available in the local store (unless they wanted to wait for a package to arrive in the mail). Now through digital downloads, listeners can access online stores that provide instant access to millions of tracks. Increasingly, listeners can get music directly from their favorite artist, even if they have yet to make a recording deal with a major studio. More and more music is being created exclusively for distribution over the Internet.[347]

Finally, consumers have vastly more choices for gaming than ever before. All three major game consoles—Microsoft Xbox, Sony PlayStation, and Nintendo Wii—now offer some form of a virtual console on the Internet, where users can download games rather than having to get the game on disc. The Xbox 360's Live Marketplace, for example, lets users find and buy games from independent developers. In addition, there are thousands of casual games available online that come in all shapes and sizes. And beyond these is the growing marketplace of games offered by mobile providers to be played on cell phones.

SAVING ENERGY: SHIFTING FROM ATOMS TO BITS

By allowing the widespread production, transmission, and consumption of virtual products—replacing bits for atoms—the Internet is paving the way to a more sustainable society. The Internet-enabled "dematerialization" of the economy, in which atoms (e.g., letters written on paper) are increasingly replaced with bits (e.g., e-mail), is leading to energy savings not just from reduced transportation, but also from reduced production of material goods. Take movies and music, for example. For most people, watching a movie at home has in the past required getting into a car and driving to the movie store. But with the emergence of high-speed broadband networks and much easier-to-use home video network systems, movies are now being offered digitally over the Internet. Likewise, instead of getting in a car to drive to the store to buy a music compact disc, increasingly consumers are buying their music from music Web sites like iTunes.com and downloading it to a digital music device. This not only eliminates the trip to the store to get the disk, it eliminates shipping from the CD manufacturer to the wholesaler and the retailer, and saves all the energy used in producing the plastic and the disk. Online music sales are growing rapidly. Apple's iTunes, the leading online music store, recently became the second most popular music retailer in the United States, behind Wal-Mart, the country's largest retail firm.[348] Apple offers over 10 million tracks and has sold more than 6 billion songs without shipping a single physical CD (or the accompanying plastic packaging) or erecting a single iTunes retail store.[349] Fuhr and Pociask have estimated that eliminating the production of CDs and their plastic cases in the United States alone could save 42 million gallons of oil per year while reducing greenhouse gas emissions by a half million tons.[350]

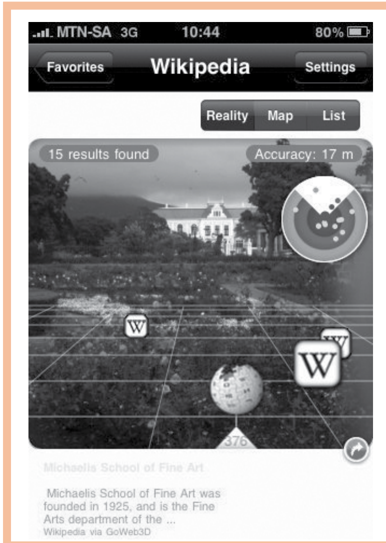
But digital movies and music are just one manifestation of the larger phenomenon of dematerialization. Paper is a prime example, as the Internet has enabled the digitization of many tasks that used to require paper, including letters, newspapers, office work, and even books, with considerable energy savings and environmental benefits. Paper manufacturing is an extremely energy-intensive process, requiring about 3,405 kilowatt-hours of energy to produce 100 tons of paper.[351] Thus, getting the news online and reading it on a personal digital assistant (PDA) releases 32 to 140 times less carbon dioxide than reading the news in a newspaper.[352] With the advent of Web-based news, newspaper circulation has declined on average 1.7 percent a year in the United States, and Fuhr and Pociask have estimated that this decline in newspaper circulation has already prevented the release of 7.9 million tons of greenhouse gases from paper news production processes.[353]

Similarly, instead of relying on paper mail, consumers and businesses are increasingly turning to the Internet to do their banking, pay bills, file taxes, and communicate generally. As a result, the use of first-class mail in the United States has been on the decline, with the number of first-class mail pieces dropping from 103.5 billion pieces in 2002 to 97.6 billion pieces in 2006, saving 184,000 tons of paper—not to mention saving the energy that would have been needed to manufacture all this paper, an estimated 7.4 million British thermal units (BTUs) annually.[354]

The Internet has had a similar impact on the use of paper checks. There is little wonder that banks have embraced Internet banking, given that processing a check costs banks approximately $1.40 compared to just 8 cents for processing an Internet-enabled bill payment. The result has been a dramatic decline in the use of paper checks, and the accompanying energy required for their printing and processing. According to the U.S. Federal Reserve, check writing in the United States has declined in recent years, going from 49.5 billion checks paid in 1995 to 36.7 billion checks paid in 2003.[355] By 2006, that number had decreased to 30 billion checks paid annually and the number of electronic payments made that year, 60 billion, doubled the number of checks written.[356]

E-commerce specifically yields significant energy savings. New e-commerce-enabled business practices like Amazon.com's centralized warehousing are actually less damaging to the environment than traditional brick-and-mortar retail operations even though such practices result in increased shipping. The energy involved in selling $100 of books is 14 times greater at a retail store than an online bookseller.[357] A study by Romm finds that a 20-mile round trip to the mall to purchase two five-pound products consumes about 1 gallon of gasoline, whereas shipping the packages 1,000 miles by truck consumes 0.1 gallon of gasoline.

Moreover, the Internet lets consumers shop virtually instead of in person. Even when shopping at some point has to be done in person—one will probably want to tour a house or test drive a vehicle before purchasing it—the Internet significantly reduces the number of houses or stores visited. For example, Ratchford, Talukdar, and Lee found that the use of the Internet to look for new cars reduced the number of dealerships shoppers visited.[358]



Layar browser, Cape Town, 2009

Looking back, the first 25 years of the Internet economy have produced Internet successes like Google, Amazon, and eBay; revolutionized industries such as retail, travel, and stock trading; and reshaped the workforce with more self-service, access to lower-cost labor, and flexible work arrangements. In addition, it has provided consumers with an unprecedented amount of access to information and powerful new tools to become "prosumers." The potential for innovation and the pace of technology moves so fast that predicting the next 25 years of the Internet economy is difficult. However, over the next decade, one can expect a host of innovative technologies, services, and business models that will continue to enhance productivity and improve quality of life. Furthermore, one can expect a number of current trends to continue in the short and moderate term.

GREATER ADOPTION OF EXISTING TECHNOLOGY

Since 1985, the Internet economy has moved out of its infancy but it still has a long way to go to reach full maturity. While many people use the most popular online applications, many more people could use the Internet. Even mainstream applications such as e-commerce, e-mail, online media, and social networking are not yet routinely used by a large segment of the adult population. Less than 50 percent use e-mail and less than 40 percent use a search engine on a typical day, and only 34 percent of Americans purchased goods or services online.[359] Over the next 25 years, much of the progress one should expect to see should come from increased adoption of existing technology. As an increasing percentage of the population integrates themselves into the Internet economy, even higher rates of productivity and societal benefits should materialize as the value of the network increases with the number of participants. The share of the population today who conduct a meager share of their lives online will likely shrink. More people are likely to spend more time online reading the news; shopping; enjoying entertainment; engaging in health, education, and work activities; and socializing. As more people go online, spurred by faster broadband service, affordable and easier to use technology, and policy initiatives that close the digital divide, such as computer ownership and digital literacy campaigns, Internet use will grow even more.

GREATER USE OF SELF-SERVICE TECHNOLOGY

As more and more users adopt Internet technology there will be further take-up of self-service technology. Calling in an order for take-out Chinese will seem as passé as using dial-up Internet, paper forms will become increasingly obsolete, and information will become even more accessible online. Greater use of self-service technology will enable an array of benefits from increased productivity to more consumer convenience to lower prices. As more people become comfortable with self-service applications in areas such as e-commerce and e-government, organizations will invest more in these technologies, and these investments will enable lower prices and the sale of more goods and services. While in-person service will never completely disappear, the future Internet economy will likely include more innovative self-service applications that empower consumers.

MORE HIGH-BANDWIDTH APPLICATIONS

Only in recent years have broadband networks reached the speeds necessary to deliver media-rich, interactive Web browsing. One trend likely to continue into the future is the adoption by consumers and businesses of faster broadband connections, especially as more content and services, such as voice over IP and streaming video, are delivered over Internet connections instead of traditional cable or phone services. Already countries with next-generation broadband networks such as Korea and Japan have seen the emergence of high-definition video applications that demand very high bandwidth. Fast Internet connections have also already generated considerable interest in cloud computing. Use of cloud computing will likely continue to grow as cloud computing service providers can provide an efficient computing platform that scales well to serve equally well either hundreds of users or millions of users.

But the true potential of next-generation high-speed broadband networks lies in the transformative new capabilities they enable.[360] These functionalities—including real-time collaboration tools such as videoconferencing and telepresence, faster file transfers, and streaming media—will support a broad range of networked applications delivering tremendous benefits to consumers, academic institutions, businesses, society, and the economy. For example, data-intensive applications, such as telepresence, will be able to flourish once faster Internet connections go mainstream both in deployment and adoption.

GREATER USE OF THE MOBILE INTERNET

Ubiquitous connectivity is likely to emerge as one of the defining attributes of the Internet economy over the next quarter century. The mobile Internet, accessible on smart phones, netbooks, tablet PCs, and mobile media devices such as video players and e-book readers, untethers users so they can enjoy the benefits of the Internet from anywhere. The mobile Internet is already available in many places—including cars, trains, and airplanes—but cost, speed, and availability are still barriers to wider adoption. Wider deployment of fourth-generation (4G) wireless technologies such as LTE or WiMax and their successors will help create the foundation for new applications and services, as the mobile speeds of tomorrow will exceed the wired speeds of today. Continued IT advancements will also enable electronics that are increasingly fast, energy-efficient, and low-cost, including wearable computing systems that may someday replace "point-and-click" with "point-and-think." And increasingly the mobile Internet will be much more than surfing a Web site while sitting in a park; it will enable engagement in a wide array of Internet enabled activities and transactions.

GROWTH OF LOCATION-BASED SERVICES

More online applications will implement or use location-based services. Location data can be used to improve the quality of search, communication tools, social networking, games, applications and targeted advertising. As applications like Twitter integrate geo-location metadata with user-generated content, other users can use location-aware applications that allow them to find data submitted by others in a specific location. For example, concert-goers can use this feature to socialize with other attendees or neighbors can use it to share information within a neighborhood.

Next-generation broadband networks will empower the Internet with expanded functionalities—including real-time collaboration tools such as videoconferencing and telepresence, faster file transfers, and streaming media—that will support a broad range of new Web-based applications.

One of the most hyped location-based services today is augmented reality (AR). AR is the addition of electronic data to the physical world. This can be implemented by overlaying contextual information, downloaded from the Internet, on a graphical representation of the physical world. For example, individuals can use the camera and display features of a smart phone to display a live view of the world around them with computer-generated information layered on top. Mobile applications, like the Layar or Wikitude browsers, allow smart phone users to combine real-world views with online information, such as Wikipedia entries associated with a specific point-of-interest or reviews about a nearby restaurant. Using an iPhone application from the company acrossair, users can find the closest subway station in New York City, learn which lines it serves, and get walking directions.[361] Similar services have long been available in Korea. Not all AR applications are limited to smart phones. A driver using a global positioning system (GPS) might view a real-time display of the road with directions embedded on the screen, rather than a simple animated map of the road.

SMART WORLD

Currently the Internet economy exists almost in parallel to the physical world. Indeed, many initially conceived of cyberspace as being a separate place then physical space. But in the future, the Internet will increasingly be integrated with the world around us. Advances in technology such as low-cost sensors, low-power processors, and advanced wireless networking are leading to the creation of an active world that is alive with information.

Already we are seeing the beginnings of this trend. Companies are offering "smart home" technology that enables individuals to control their lights from a laptop, turn on their heaters using their iPhone, and schedule recordings on their TiVos from their offices. Utilities are rolling out smart meters, electricity meters that automate a range of energy management functions such as collecting energy usage and starting and stopping services. In the future, these meters will offer variable pricing to consumers so that, for example, they can adjust their energy usage to off-peak times to save money and be more energy efficient. Intelligent transportation systems integrated with GPS navigators such as Telenav on smart phones already let users know about real-time traffic conditions and advise drivers on optimal route navigation patterns to take less congested routes. Future advances will make these systems bi-directional, integrating traffic patterns with traffic signal lights. The adoption of IPv6 (Internet Protocol version 6) will mean that Internet addresses will be available for every device, sensor, and even person on the planet. Once IPv6 is fully implemented, there will be more IP addresses than grains of sand on the planet. IPv6 will also provide enhanced security, improved network management, and a better mobile experience.

Finally, a world that is alive with information will also mean more personalization. Devices connected to the Internet will be able to deliver services and information customized for each individual.

CONCLUSION

As this study has comprehensively documented, the Internet economy has transformed almost every facet of life for citizens in developed countries, and is increasingly doing so for those in developing countries as well. The commercial Internet has unleashed new businesses models, ushered in a plethora of new products and services, drawn individuals and communities throughout the world together in ways never before possible, substantially increased consumer convenience, and dramatically increased the quality of life and incomes for millions of the world's citizens.

From humble beginnings 25 years ago, the commercial Internet has grown to become a general purpose technology whose impact has already left an indelible mark on history. Yet going forward, we should expect to see even more, as global Internet adoption continues to increase, as connectively technologies bring faster Internet speeds into homes and businesses, and as access to the Internet proliferates across a multitude of mobile devices and platforms. In fact, some experts believe that the Internet revolution is, even now, less than 15 percent complete.[362]

To ensure that the commercial Internet reaches its full potential, nations must continue to remain vigilant to ensure the trust and security of the Internet; to support both the deployment of broadband technologies that bring high-speed Internet access into homes and businesses and the proliferation of personal or mobile computing devices through which to access the Internet; to ensure that companies have incentives to invest in Internet-enabled business practices; and to ensure that their citizenry becomes digitally literate so they can enjoy the benefits made possible by the Internet economy.

So to the commercial Internet, congratulations on hitting your 25th birthday; you're just starting to enter the prime of your working years!

Appendix A: Total domain names per OECD country, and as a percent of world total, 2008

Country	Total Domains	Percent of World Total
United States	55,308,080	34.14%
Germany	17,835,570	11.01%
China	15,000,000	9.26%
United Kingdom	11,555,646	7.13%
Canada	4,414,311	2.72%
The Netherlands	4,282,132	2.64%
France	3,515,169	2.17%
Italy	2,886,978	1.78%
Australia	2,779,424	1.72%
Japan	2,678,809	1.65%
Spain	2,255,508	1.39%
Korea	1,951,926	1.20%
Switzerland	1,553,672	0.96%
Sweden	1,240,015	0.77%
Denmark	1,164,023	0.72%
Belgium	1,140,340	0.70%
Poland	1,115,309	0.69%
Turkey	1,099,517	0.68%
Austria	1,093,258	0.67%
Norway	665,277	0.41%
Czech Republic	571,994	0.35%
Mexico	563,035	0.35%
New Zealand	548,887	0.34%
Finland	432,794	0.27%
Hungary	430,925	0.27%
Portugal	407,675	0.25%
Ireland	352,866	0.22%
Greece	336,684	0.21%
Slovak Republic	183,715	0.11%
Luxembourg	80,439	0.05%
Iceland	39,223	0.02%
OECD Total	125,591,660	77.53%
World Total	162,000,000	100.00%

Source: OECD, Communication Outlook 2009

Appendix B: Internet selling and purchasing by industry 2006, percent of businesses

		Selling	Purchasing
Australia (2005)	Construction	20.7	44.0
	Manufacturing	20.6	32.6
	Real estate, renting & business activities	11.1	41.6
	Transport, storage & communication	36.4	49.9
	Wholesale	25.7	66.4
	Retail	11.1	40.6
	All industries	17.2	45.2
Austria	Construction	3.8	26.3
	Manufacturing	14.4	30.6
	Real estate, renting & business activities	7.5	47.1
	Transport, storage & communication	14.4	32.9
	Wholesale & Retail	17.8	39.8
	All industries	15.4	36.5
Belgium	Construction	5.3	10.5
	Manufacturing	16.3	11.6
	Real estate, renting & business activities	10.8	30.9
	Transport, storage & communication	14.8	8.7
	Wholesale & Retail	18.2	17.0
	All industries	14.8	15.9
Canada	Construction	0.6	65.5
	Manufacturing	11.9	67.9
	Real estate, renting & business activities	20.0	53.8
	Transport, storage & communication	7.0	49.5
	Wholesale	16.0	66.6
	Retail	19.9	57.6
	All industries	12.5	61.6
Czech Republic	Construction	3.7	11.1
	Manufacturing	8.1	13.9
	Real estate, renting & business activities	8.5	24.0
	Transport, storage & communication	8.9	14.1
	Wholesale & Retail	9.0	20.4
	All industries	8.2	16.9
Denmark	Construction	21.5	27.9
	All industries	33.9	33.9
Finland	Construction	..	12.3
	Manufacturing	18.8	..
	Real estate, renting & business activities	..	32.1
	Transport, storage & communication	13.4	..
	Wholesale & Retail	..	33.5
	All industries	13.6	23.1
France	Construction	6.8	8.5
	Manufacturing	24.9	18.0
	Real estate, renting & business activities	17.1	25.2
	Transport, storage & communication	21.2	16.8
	Wholesale & Retail	16.3	28.2
	All industries	18.4	20.7

Appendix B (continued)

		Selling	Purchasing
Germany	Construction	8.9	38.5
	Manufacturing	22.5	45.9
	Real estate, renting & business activities	11.8	58.7
	Transport, storage & communication	17.6	38.7
	Wholesale & Retail	18.2	48.3
	All industries	18.1	47.6
Greece	Construction	0.7	4.5
	Manufacturing	4.5	9.1
	Real estate, renting & business activities	6.1	17.0
	Transport, storage & communication	11.0	9.5
	Wholesale & Retail	4.8	14.3
	All industries	7.3	11.2
Hungary	Construction	1.0	2.5
	Manufacturing	10.9	9.6
	Real estate, renting & business activities	6.6	10.2
	Transport, storage & communication	8.1	7.2
	Wholesale & Retail	9.0	17.5
	All industries	8.6	10.8
Iceland	Construction	8.3	17.5
	Manufacturing	19.5	35.4
	Real estate, renting & business activities	25.7	50.9
	Transport, storage & communication	33.7	23.3
	Wholesale & Retail	23.2	47.9
	All industries	22.0	37.6
Ireland	Construction	3.9	34.6
	Manufacturing	23.8	54.4
	Real estate, renting & business activities	14.0	65.8
	Transport, storage & communication	31.1	57.4
	Wholesale & Retail	21.4	49.7
	All industries	22.7	52.8
Italy	Construction	0.7	6.7
	Manufacturing	1.6	6.8
	Real estate, renting & business activities	2.2	20.2
	Transport, storage & communication	0.8	8.0
	Wholesale & Retail	3.0	14.4
	All industries	2.8	9.7
Japan (2005)	Construction	3.5	15.7
	Manufacturing	14.0	21.3
	Transport, storage & communication	8.8	16.0
	All industries	15.2	20.1

Appendix B (continued)

		Selling	Purchasing
Korea (2005)	Construction	8.0	36.5
	Manufacturing	9.2	29.1
	Real estate, renting & business activities	5.0	30.7
	Transport, storage & communication	7.8	28.1
	Wholesale	15.0	27.8
	Retail	9.1	33.1
	All industries	7.5	32.5
Luxembourg	Construction	6.1	23.0
	Manufacturing	16.3	28.8
	Real estate, renting & business activities	8.4	44.9
	Transport, storage & communication	14.5	24.1
	Wholesale & Retail	12.5	31.3
	All industries	11.5	30.3
Mexico (2003)	Construction	4.0	6.0
	Manufacturing	2.0	1.8
	Real estate, renting & business activities	2.1	6.4
	Transport, storage & communication	1.1	2.2
	Wholesale	1.3	2.7
	Retail	16.7	5.6
	All industries	2.2	2.2
Netherlands	Construction	10.3	26.3
	Manufacturing	28.2	31.0
	Real estate, renting & business activities	17.5	38.4
	Transport, storage & communication	31.1	26.8
	Wholesale & Retail	25.6	30.6
	All industries	23.3	31.8
New Zealand	Construction	23.7	56.2
	Manufacturing	42.6	58.2
	Real estate, renting & business activities	34.6	76.4
	Transport, storage & communication	50.4	53.9
	Wholesale	41.5	56.5
	Retail	28.0	48.8
	All industries	36.7	58.8
Norway	Construction	26.7	47.1
	Manufacturing	..	40.6
	Real estate, renting & business activities	22.7	62.5
	Transport, storage & communication	..	37.1
	Wholesale & Retail	27.2	..
	All industries	27.5	48.8
Poland	Construction	3.2	10.0
	Manufacturing	10.4	12.7
	Real estate, renting & business activities	5.7	17.6
	Transport, storage & communication	13.5	15.3
	Wholesale & Retail	10.3	20.8
	All industries	9.3	15.6

Appendix B (continued)

		Selling	Purchasing
Portugal	All industries	7.1	14.4
Spain	Construction	2.1	8.0
	Manufacturing	10.1	12.1
	Real estate, renting & business activities	6.3	19.8
	Transport, storage & communication	9.6	14.6
	Wholesale & Retail	9.3	22.2
	All industries	8.4	14.7
Sweden	Construction	14.4	33.5
	Manufacturing	25.8	38.4
	Real estate, renting & business activities	19.5	56.0
	Wholesale & Retail	30.0	51.7
	All industries	23.9	44.4
Switzerland (2005)	Construction	6.0	45.0
	Manufacturing	17.0	56.0
	Services	31.0	59.0
	All industries	25.0	57.0
United Kingdom	Construction	18.8	32.4
	Manufacturing	46.0	51.8
	Real estate, renting & business activities	22.7	60.4
	Transport, storage & communication	31.1	41.1
	Wholesale & Retail	28.8	47.8
	All industries	30.4	50.6

Source: OECD, The Future of the Internet Economy, 2008

Appendix C: Secure servers, OECD countries, 2008[363]

Country	Number Secure Servers, 2008	Percent Growth, 1998-2008	Secure Servers Per GDP Rank
Iceland	483	3,615%	1
New Zealand	3,881	4,212%	2
Denmark	5,242	11,814%	3
Australia	19,264	2,948%	4
United States	343,164	2,239%	5
Netherlands	15,951	12,460%	6
United Kingdom	51,386	7,097%	7
Canada	28,905	3,011%	8
Switzerland	6,992	4,500%	9
Sweden	6,568	4,430%	10
Finland	3,318	4,779%	11
Ireland	2,784	4,871%	12
Germany	41,954	8,427%	13
Norway	3,654	6,544%	14
Japan	55,660	12,874%	15
Austria	3,762	3,739%	16
Luxembourg	406	3,591%	17
Belgium	2,418	4,550%	18
Czech Republic	1,396	7,247%	19
Spain	7,267	2,941%	20
France	10,076	4,439%	21
Portugal	1,102	3,981%	22
Poland	2,702	11,648%	23
Hungary	733	3,972%	24
Korea	4,992	13,037%	25
Italy	5,082	2,943%	26
Slovak Republic	252	1,580%	27
Greece	642	7,925%	28
Mexico	1,531	5,788%	29
OECD Total	635,315	3,143%	

Source: OECD, Communication Outlook 2009

Appendix D: Number of domain names by U.S. state, 2007

2008 Rank	State	Domain Names	Domains/Firm
1	Nevada	672,019	12.3
2	Virginia	1,974,303	11.12
3	Arizona	1,041,037	8.81
4	Utah	533,779	8.48
5	Washington	1,448,424	7.43
6	California	7,473,464	6.95
7	Hawaii	209,336	6.87
8	Florida	2,866,944	6.05
9	Delaware	155,168	6.03
10	Texas	2,315,673	5.61
11	New York	2,430,780	5
12	Oregon	533,214	4.99
13	Massachusetts	913,517	4.98
14	Colorado	754,964	4.95
15	Maryland	686,690	4.92
16	Vermont	104,386	4.87
17	Georgia	990,819	4.79
18	New Hampshire	183,381	4.51
19	Tennessee	498,795	4.47
20	Illinois	1,253,195	4.31
21	Connecticut	410,772	4.19
22	North Carolina	773,020	4.14
23	New Jersey	1,043,294	4.02
24	Minnesota	530,957	3.98
25	New Mexico	157,989	3.66
26	Alaska	61,503	3.63
27	Pennsylvania	1,012,825	3.61
28	Michigan	769,634	3.59
29	Ohio	822,673	3.56
30	Rhode Island	118,492	3.52
31	Indiana	433,342	3.45
32	South Carolina	328,957	3.43
33	Missouri	464,376	3.4
34	Idaho	152,911	3.3
35	Louisiana	309,208	3.18
36	Oklahoma	245,448	3.16
37	Alabama	274,224	3.11
38	Wisconsin	389,895	3.05
39	Montana	108,336	3.04
40	Kansas	195,794	2.8
41	Maine	113,414	2.76
42	Kentucky	233,599	2.75
43	Nebraska	126,956	2.7
44	Wyoming	55,296	2.67
45	North Dakota	51,347	2.62
46	Iowa	174,353	2.47
47	Arkansas	137,676	2.2
48	South Dakota	53,039	2.18
49	Mississippi	103,822	1.9
50	West Virginia	69,402	1.89
	Total	**36,762,442**	**5.09**

Source: Matthew Zook, 2008

Appendix E: U.S. B2B e-commerce by sector, 2002-2007 ($M)

Year		Manufacturing	Wholesalers	Retail Trade	Selected Services
2007	**Total**	**$5,305,935**	**$5,782,065**	**$3,994,823**	**$6,763,712**
	E-commerce	$1,855,719	$1,226,071	$126,697	$124,122
	Percent of Total	35.0	21.2	3.2	1.8
2006	**Total**	**$5,015,553**	**$5,526,221**	**$3,869,536**	**$6,385,177**
	E-commerce	$1,566,799	$1,193,962	$107,014	$103,697
	Percent of Total	31.2	21.6	2.8	1.6
2005	**Total**	**$4,742,076**	**$5,164,302**	**$3,687,364**	**$5,949,425**
	E-commerce	$1,343,852	$1,118,274	$87,846	$89,712
	Percent of Total	28.3	21.7	2.4	1.5
2004	Total	$4,308,971	$4,799,679	$3,474,340	$5,539,481
	E-commerce	$996,174	$962,675	$71,087	$79,726
	Percent of Total	23.1	20.1	2.0	1.4
2003	**Total**	**$4,015,081**	**$4,345,336**	**$3,265,477**	**$5,114,011**
	E-commerce	$842,666	$880,908	$56,719	$64,310
	Percent of Total	21.0	20.3	1.7	1.3
2002	**Total**	**$3,920,632**	**$4,151,597**	**$3,134,322**	**$4,900,995**
	E-commerce	$751,985	$806,589	$44,925	$59,966
	Percent of Total	19.2	19.4	1.4	1.2
2001	**Total**	**$3,970,500**	**NA**	**$3,067,725**	**NA**
	E-commerce	$724,228	NA	$34,451	NA
	Percent of Total	18.2	NA	1.1	NA
2000	**Total**	**$4,208,582**	**NA**	**$2,988,756**	**NA**
	E-commerce	$755,807	NA	$27,720	NA
	Percent of Total	18.0	NA	0.9	NA

Source: E-Stats, 2009

Appendix F: B2B e-commerce within U.S. manufacturing industries, 2007 ($M)

Industry	E-commerce	Percent
Total Manufacturing	$1,855,719	35%
Food products manufacturing	$202,684	35%
Beverage and tobacco manufacturing	$72,049	56%
Textile mills	$14,188	40%
Textile product mills	$13,499	47%
Apparel manufacturing	$7,280	30%
Leather and allied product manufacturing	$1,347	24%
Wood product manufacturing	$19,422	19%
Paper manufacturing	$61,128	35%
Printing and related support activities	$25,645	25%
Petroleum and coal products manufacturing	$189,934	31%
Chemicals manufacturing	$247,150	34%
Plastics and rubber products manufacturing	$61,405	29%
Nonmetallic mineral products manufacturing	$22,669	18%
Primary metals manufacturing	$79,431	31%
Fabricated metal products manufacturing	$82,062	24%
Machinery manufacturing	$109,197	31%
Computer and electronic products manufacturing	$141,551	36%
Electrical equipment, appliances, and components	$40,606	31%
Transportation equipment manufacturing	$409,424	56%
Furniture and related products manufacturing	$22,489	26%
Miscellaneous manufacturing	$32,558	22%

Source: U.S. Bureau of the Census, 2007

Appendix G: Percent of turnover from e-commerce in Europe by firm size, 2009

Country	Large (>250)	Medium (50-249)	SME (10-249)	Small (10-49)
EU 27	17	10	7	4
EU 15	17	10	7	4
Bulgaria	1	1	2	3
Czech Republic	22	10	9	8
Germany	20	12	9	5
Ireland	29	21	22	24
Greece	2	3	2	1
Spain	15	7	5	4
France	17	15	10	4
Cyprus	1	1	1	1
Latvia	2	8	6	3
Lithuania	6	15	12	8
Hungary	24	8	5	3
Malta	52	3	2	2
Netherlands	14	12	10	8
Austria	16	11	8	4
Poland	11	N/A	4	N/A
Portugal	13	15	11	6
Romania	3	1	1	1
Slovenia	11	N/A	N/A	N/A
Slovakia	17	3	3	3
Sweden	N/A	N/A	N/A	5
United Kingdom	21	10	7	4
Croatia	14	16	13	11
Norway	25	22	17	13

Source: E-Stats, 2009

ENDNOTES

[1] Interestingly, Microsoft Windows also turns 25 in 2010, as Version 1.0 of Windows shipped in 1985. No doubt there has been complementarity in the successful global diffusion and adoption of both the Internet and Windows.

[2] Internet World Stats, "Top 20 Countries With the Highest Number of Internet Users," September 30, 2009, http://www.internetworldstats.com/top20.htm.

[3] Global sales of medicine are approximately $780 billion, investment in renewable energy $400 billion, and government R&D $300 billion.

[4] John Deighton and John Quelch, *Economic Value of the Advertising-Supported Internet Ecosystem,* Hamilton Consulting, 2009, http://www.iab.net/media/file/Economic-Value-Report.pdf.

[5] Robert Atkinson, The Past and Future of America's Economy: Long Waves of Innovation that Power Cycles of Growth (Northampton, Massachusetts: Edward Elgar, 2004).

[6] Richard G. Lipsey, "Transformative Technologies in the Past Present and Future: Implications for the U.S. Economy and U.S Economic Policy," presentation at ITIF Breakfast Forum, July 15, 2008, http://www.itif.org/files/2008-07-15-lipsey.pdf.

[7] See Richard G. Lipsey, Kenneth I. Carlaw, and Clifford T. Bekar, *Economic Transformations: General Purpose Technologies and Long Term Economic Growth* (New York: Oxford University Press, 2005).

[8] J. Postel and J. Reynolds, "RFC 920, Domain Requirements," Network Working Group, October 1984, http://tools.ietf.org/rfc/rfc920.txt. The other top-level domains were .org, .edu, .gov, .mil, and temporary domain .arpa.

[9] A portion of the ARPANET directory from January 1974 can be seen at http://www.bortzmeyer.org/files/hosts.txt-1974.pdf. Its format is very similar to the "hosts.txt" file maintained by SRI NIC into the late 1980s.

[10] Postel and Reynolds, "RFC 920, Domain Requirements."

[11] P. Mockapetris, "RFC 882, Domain Names—Concepts and Facilities," Network Working Group, November 1983, http://tools.ietf.org/rfc/rfc882.txt.

[12] The first-ever domain registered was nordu.net in Norway. As it maintained a root name server, it needed a name.

[13] In 1985, cmu.edu, purdue.edu, rice.edu, berkeley.edu, ucla.edu, rutgers.edu, and bbn.com registered on April 24th; mit.edu on May 23rd; think.com on May 24th; css.gov in June; and mitre.org, and mitre.uk in July.

[14] iWhoIs.com, "100 oldest registered .com domains," https://www.iwhois.com/oldest/.

[15] Brad Templeton, "The History of ClariNet.com," Brad Templeton's Home Page, June 2009, http://www.templetons.com/brad/clarinet-history.html.

[16] Ibid.

[17] Rajiv C. Shah and Jay P. Kesan, "The Privatization of the Internet's Backbone Network," National Science Foundation, http://www.governingwithcode.org/journal_articles/pdf/Backbone.pdf.

[18] Atkinson, The Past and Future of America's Economy.

[19] Kevin Kelly, *New Rules for the New Economy* (New York: Viking Penguin, 1998), 56.

[20] Peter Schwartz and Peter Leyden, "The Long Boom: A History of the Future," *Wired*, issue 5.07, July 1997, http://www.wired.com/wired/archive/5.07/longboom_pr.html.

[21] Robert Atkinson, "It's Better Thank You Think: Recent IT Trends," Progressive Policy Institute, http://www.ppionline.org/documents/Atkinson.pdf.

[22] Nicholas G. Carr, "Does IT Matter?" *Harvard Business Review*, May 2003, 10.

[23] Carlota Perez, *Technological Revolutions and Financial Capital* (Northampton, Massachusetts: Edward Elgar, 2003), 36.

[24] In the United States, annual productivity in recessionary quarters from 1947 to 1995 was just 0.93 percent per year. In contrast, annual productivity in recessionary quarters from 1996 to the present was more than three times greater, at 3.07 percent per year. Data source: U.S. Bureau of Economic Analysis and National Bureau for Economic Research (NBER).

[25] Daniel Gross, "In Praise of Bubbles," *Wired*, issue 14.02, February, 2006, http://www.wired.com/wired/archive/14.02/bubbles.html.

[26] Ibid.

[27] Atkinson, The Past and Future of America's Economy, 15.

[28] Ibid.

[29] OECD Broadband Portal, "OECD Broadband Statistics, December 2004"; see link, "Broadband penetration, historic, G7 countries" at http://www.oecd.org/document/60/0,3343,en_2649_34225_2496764_1_1_1_1,00.html.

[30] Gross, "In Praise of Bubbles."

[31] nVision, "E-Commerce across Europe: Progress and prospects," October 2008, http://www.eaca.be/_upload/documents/publications/E-commerce%20across%20Europe.pdf.

[32] Kent German, "Top 10 dot-com flops," CNET.com, http://www.cnet.com/1990-11136_1-6278387-1.html.

[33] Mathew Honan and Steven Leckart, "The Dotcom Boom, 10 Years After," *Wired*, March 2010, http://www.wired.com/magazine/2010/02/10yearsafter/.

[34] Robert Atkinson *et al., "*The Need for Speed: The Importance of Next-Generation Broadband Networks," Information Technology and Innovation Foundation, March 5, 2009, http://www.itif.org/files/2009-needforspeed.pdf.

[35] Ibid.

[36] Honan and Leckart, "The Dotcom Boom, 10 Years After."

[37] Atkinson, The Past and Future of America's Economy, 10.

[38] Nate Lanxon, "The greatest defunct Web sites and dot-com disasters," CNET UK, June 5, 2008, http://crave.cnet.co.uk/gadgets/0,39029552,49296926-6,00.htm.

[39] David Heath and Sharon Chan, "The two faces of InfoSpace," *Seattle Times*, http://seattletimes.nwsource.com/art/news/business/infospace/infospaceTimelineDay1_2_intro.swf.

[40] Timelines.com, "Super Bowl XXXIV Features Seventeen Dot-Com Companies," January 30, 2000, http://timelines.com/2000/1/30/super-bowl-xxxiv-features-seventeen-dot-com-companies.

[41] Ranjit Goswami and Chinmoy Kumar, "New-Age Dot-coms: Creative Destruction or Digital Anarchy?" 4, http://www.iitk.ac.in/infocell/announce/convention/papers/Context and Human Resource-08-Ranjit Goswami,Chinmoy Kumar.pdf.

[42] David Kirsch and Brent Goldfarb, "Small Ideas, Big Ideas, Bad Ideas, Good Ideas: 'Get Big Fast' and Dot Com Venture Creation," University of Maryland Robert H. Smith School, Research Paper No. RHS-06-049, November 17, 2006, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=946446.

[43] Kirsch and Goldfarb, "Small Ideas, Big Ideas, Bad Ideas, Good Ideas," 7.

[44] Honan and Leckart, "The Dotcom Boom, 10 Years After."

[45] Report co-author Stephen Ezell was a co-founder of Brivo Systems.

[46] Amy Borrus, "Leave It in the Box," *BusinessWeek Online*, December 11, 2000, http://www.businessweek.com/2000/00_50/b3711085.htm.

[47] Tekes, *Seizing the White Space: Innovative Service Concepts in the United States*, Technology Review, 205, 2007, 72-74, http://www.tekes.fi/en/document/43000/innovative_service_pdf.

[48] Atkinson, The Past and Future of America's Economy, 8.

[49] C. K. Prahalad and M.S. Krishnan, The New Age of Innovation: Driving Cocreated Value Through Global Networks (New York: McGraw Hill, 2008), 110.

[50] Raymond R. Panko, "IT Employment Prospects: Beyond the Dotcom Bubble," *European Journal of Information Systems*, 17, (2008): 182-197, http://www.palgrave-journals.com/ejis/journal/v17/n3/pdf/ejis200819a.pdf.

[51] Guido Buenstorf and Dirk Fornahl, "B2C—Bubble to Cluster: The Dot-com Boom, Spin-off Entrepreneurship, and Regional Agglomeration," *Journal of Evolutionary Economics*, 19 (2009): 349-378, http://dimetic.dime-eu.org/dimetic_files/Buenstorf%20Fornahl%20JEE%20Intershop.pdf.

[52] Status of Internet Usage, "Internet Users," Korean Internet and Security Agency, http://isis.nida.or.kr/eng/.

[53] comScore, "The 2009 U.S. Digital Year in Review: A Recap of the Year in Digital Marketing," February 2010, http://www.comscore.com/Press_Events/Presentations_Whitepapers/2010/The_2009_U.S._Digital_Year_in_Review/%28language%29/eng-US.

[54] Daniel Castro, Richard Bennett, and Scott Andes, "Steal These Policies: Strategies for Reducing Digital Piracy," Information Technology and Innovation Foundation, 2009, http://www.itif.org/files/2009-digital-piracy.pdf.

[55] Symbolics.com hadn't changed ownership during the nearly 25 years that followed its initial registration. However, domain name investment company XF.com Investments recently purchased the domain name for an undisclosed sum.

[56] One reason for the high daily number in comparison to the monthly number is that some domains are only live for a few days. See Domain Tools.com, "DomainTools.com Whois Record (Domain Tools)," http://www.domaintools.com/Internet-statistics/.

[57] Zooknic Internet Intelligence, "History of gTLD domain name growth," Zooknic, http://www.zooknic.com/Domains/counts.html.

[58] Ibid.

[59] VeriSign, "The Domain Name Industry Brief," 6, issue 1, February 2009, http://www.verisign.com/domain-name-services/domain-information-center/domain-name-resources/domain-name-report-feb09.pdf.

[60] Author's calculation using data from VeriSign's quarterly "The Domain Name Industry Briefs," from 2004-2009.

[61] Ibid.

[62] Domain Tools, "Domain names created and active," Internet Statistics, http://www.domaintools.com/Internet-statistics/.

[63] VeriSign, "Domain Name Industry Brief."

[64] Ibid.

[65] An online presence can be anything from advertising online to actually executing transactions.

[66] Daniel Britton and Stephen McGonegal, *The Digital Economy Fact Book, Ninth Edition 2007,* The Progress and Freedom Foundation, 2007, http://www.pff.org/issues-pubs/books/factbook_2007.pdf.

[67] Alexa, "Top Sites by Category," http://www.alexa.com/topsites/category.

[68] Alexa, "Top Sites in Albania", http://www.alexa.com/topsites/countries/AL.

[69] Bruce W.N. Lo and Faye J. Kao, "Variation in Country-Based Ranking Lists Among Consumers' Choices of Top E-Commerce Web Sites: Implications for International Marketing," *International Journal of Business and Information,* 3, no. 3, June 2008.

[70] John Deighton and John Quelch, *Economic Value of the Advertising-Supported Internet Ecosystem.*

[71] Alexa, "Top 1,000,000 Sites 2009," www.alexa.com. Note: Firms with no identification as a pure-play or brick-and-click are foreign firms whose nature could not be divined. Media companies are identified as brick-and-clicks.

[72] OECD, *Information Technology Outlook 2008,* January 2009, http://www.oecd.org/document/20/0,3343,en_2649_33757_41892820_1_1_1_1,00.html.

[73] Ibid.

[74] comScore, "State of the U.S. Online Retail Economy in Q3 2009," November 12, 2009, http://www.comscorenetworks.com/layout/set/popup/request/Presentations/2009/State_of_the_U.S._Online_Retail_Economy_in_Q3_2009_PDF_Request?req=slides&pre=State+of+the+U.S.+Online+Retail+Economy+in+Q3+2009.

[75] Jeff Mayer, "E-Tailing and Its Prospects—Great Expectations Reconsidered," Center for Economic Studies, Working Paper 6-16, 2006.

[76] Ibid.

[77] comScore, "State of the U.S. Online Retail Economy in Q3 2009."

[78] Mary Meeker, "Technology/Internet Trends," Morgan Stanley, November 5, 2008, http://www.morganstanley.com/institutional/techresearch/pdfs/TechTrendsWeb2_110508.pdf.

[79] Ibid.

[80] Weights are: Retail percent of GDP, 0.5; Percent of citizens who have purchased online, 0.5; Percent of firms purchasing online, 1.0; Domain names per firm, 0.5; Percent of firms with Web sites, 0.75; Secure servers per 100,000 inhabitants, 0.75; E-turnover as a percent of total turnover, 1.0.

[81] Group scores were created from total standard deviations multiplied by appropriate weights.

[82] For ICT investment indicators see Robert Atkinson and Scott Andes, *The Atlantic Century*, Information Technology and Innovation Foundation, 2009, http://www.itif.org/files/2009-atlantic-century.pdf.

[83] Sources by indicator: **Retail:** United Kingdom, Centre for Retail Research, 2009; United States, U.S. Department of Commerce, 2009; Japan, Ministry of Economy, Trade and Information, 2008; European Countries, Forrester, 2009; GDP data from the International Monetary Fund, World Economic Outlook, October 2009. **Citizens purchasing online:** OECD Key ICT Indicators; Eurostat 2008. **Percent firms purchasing:** OECD Key ICT Indicators, 2009. **Domain names per firm:** OECD *Communication Outlook 2009*. **Firms with Web sites:** UNCTAD*, Information Economy Report 2009*. **Secure servers:** OECD *Communication Outlook*, 2009. **E-turnover**: United States, U.S. Bureau of the Census, 2009; Korea, Korean Ministry of Information, 2009; Japan, Ministry of Economy, Trade and Information, 2008; European Countries, Eurostar, 2008.

[84] "Languages Used on the Internet," Internet Statistics, www.Internetworldstats.com.

[85] Ibid.

[86] Ibid.

[87] OECD, *Communications Outlook 2009*, August 2009, http://www.oecd.org/document/44/0,3343,en_2649_34225_43435308_1_1_1_1,00.html.

[88] Counting .coms, .nets and ccTLDs.

[89] OECD, Communications Outlook 2009.

[90] Domain name data provided by OECD *Communications Outlook 2009*, enterprise data provided by World Bank Group Entrepreneurship data, 2008.

[91] Deighton and Quelch, Economic Value of the Advertising-Supported Internet Ecosystem.

[92] Britton and McGonegal, The Digital Economy Fact Book, Ninth Edition.

[93] OECD, Communication Outlook 2009.

[94] Ibid.

[95] Nitish Singh and Paul D. Boughton, "Measuring Website Globalization: A Cross-Sectional Country and Industry Level Analysis," *Journal of Website Promotion*, 1, 3 (2005): 3-20.

[96] The United Kingdom Office for National Statistics, "E-commerce and information and communication technology (ICT) activity, 2008," November 27, 2009, http://www.statistics.gov.uk/pdfdir/ecom1109.pdf.

[97] Orit Rotem-Mindali and Ian Salomon, "The Impacts of E-retail on the Choice of Shopping Trips and Delivery: Some Preliminary Findings," *Transportation Research Part A: Policy and Practice,* 41, no. 2 (2007): 176-189.

[98] OECD, *The Future of the Internet Economy: A Statistical Profile*, June 17-18, 2008, http://www.oecd.org/dataoecd/44/56/40827598.pdf.

[99] Grant Eskelsen, Adam Marcus, and W. Kenneth Ferree, *The Digital Economy Fact Book, Tenth Edition, 2008-2009*, The Progress and Freedom Foundation, 2009, http://www.pff.org/issues-pubs/books/factbook_10th_Ed.pdf.

[100] Data for Europe from *The Digital Economy Fact Book, Tenth Edition*. U.S. data is adult population per e-commerce spending.

[101] Of the countries studied, see OECD, The Future of the Internet Economy: A Statistical Profile.

[102] OECD, The Future of the Internet Economy: A Statistical Profile.

[103] OECD, Communications Outlook 2009.

[104] Ibid.

[105] Leora Klapper, *2008 World Bank Group Entrepreneurship Survey*, World Bank, 2008, http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:21942814~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html.

[106] Barlow Research, "Beyond Technology: Managing the Customer Experience," September 25, 2009, http://www.barlowresearch.com/viewrecord.lasso?-KeyValue=7886.

[107] Domain name data from Matthew Zook, University of Kentucky, 2007. Population data from U.S. Census, American Fact Finder, http://factfinder.census.gov/servlet/SAFFPopulation?_submenuId=population_0&_sse=on.

[108] Robert Atkinson and Scott Andes, *2008 State New Economy Index*, Information Technology and Innovation Foundation, 2009, http://www.itif.org/files/2008_State_New_Economy_Index.pdf.

[109] Ibid. U.S. total enterprises to .com domain names is different here than in figure 10 because there are more enterprises than firms. Unfortunately, data on global enterprises were unavailable.

[110] Ibid.

[111] Seasonally adjusted.

[112] U.S. Census Bureau, "Quarterly E-Commerce Report," 2010, http://www.census.gov/retail/#ecommerce.

[113] Ibid.

[114] comScore, "comScore Reports $29.1 Billion in U.S. Retail E-Commerce Spending for Full November-December Holiday Season, Up 4 Percent vs. Year Go," January 2010, http://www.comscore.com/Press_Events/Press_Releases/2010/1/comScore_Reports_29.1_Billion_in_U.S._Retail_E-Commerce_Spending_for_Full_November-December_Holiday_Season_Up_4_Percent_vs._Year_Ago.

[115] U.S. Department of Commerce, *E-Stats Report 2007*, 2009, http://www.census.gov/econ/estats/2007/2007reportfinal.pdf.

[116] Britton and McGonegal, The Digital Economy Fact Book, Ninth Edition.

[117] comScore, "comScore Reports $29.1 Billion in U.S. Retail E-Commerce Spending."

[118] Kenneth Corbin, "E-tailers See 4 Percent Growth in Holiday Spending," Ecommerce-guide.com, January 7, 2010, http://www.ecommerce-guide.com/news/article.php/3857136.

[119] Britton and McGonegal, The Digital Economy Fact Book, Ninth Edition.

[120] Lee Rainie, "Internet, broadband, and cell phone statistics," Pew Internet & American Life Project, January 2010, http://www.pewInternet.org/~/media//Files/Reports/2010/PIP_December09_update.pdf.

[121] Census Bureau, *2007 E-Stats*.

[122] Ibid.

[123] Ibid.

[124] Mike Sachoff, "More Americans Banking Online," August 27, 2008, WebProNews, http://www.webpronews.com/topnews/2008/08/27/more-americans-banking-online.

[125] Eskelsen, Marcus, and Ferree, The Digital Economy Fact Book, Tenth Edition.

[126] U.S. Census Bureau, *2007 E-Stats*.

[127] nVision, "E-commerce across Europe, Progress and prospects."

[128] Ibid.

[129] Thomas Fuller, "In Estonia, e-commerce, e-banking, e-parking," *The New York Times,* September 13, 2004, http://www.nytimes.com/2004/09/13/business/worldbusiness/13iht-estonia13_ed3_.html.

[130] OECD, Information Technology Outlook 2009.

[131] Eurostat, Information Society Statistics Database, European Commission, 2009, http://epp.eurostat.ec.europa.eu/portal/page/portal/information_society/data/database.

[132] Ibid.

[133] Ibid.

[134] http://advertising.microsoft.com/sverige/wwdocs/user/sv-se/newsandevents/events/EIAA%20Mediascope%20Europe%20and%20Online%20Shoppers%20-%20Sweden%20Focus28.01.08.pps.

[135] Ibid.

[136] Ibid.

[137] Britton and McGonegal, The Digital Economy Fact Book, Ninth Edition.

[138] Stephen Ezell, "Explaining International IT Application Leadership: Contactless Mobile Payments," Information Technology and Innovation Foundation, November 2009, http://www.itif.org/files/2009-mobile-payments.pdf.

[139] Ministry of Economy, Trade and Industry, "Use of Networks in Business," 2008, http://www.soumu.go.jp/english/wp/pdf/chapter1-3.pdf.

[140] Ministry of Economy, Trade and Industry, Results of "Research in IT Utilization in Japan 2008," http://www.meti.go.jp/english/press/data/20091014_01.html.

[141] Ministry of Economy, Trade and Industry, "Use of Networks in Business."

[142] Michael Lesk, "South Korea's Way to the Future," *IEEE Privacy & Security,* 5, no. 2 (2007), http://www.computer.org/portal/web/csdl/doi/10.1109/MSP.2007.42.

[143] "E-commerce in China reports 137.2 percent despite recession," *Analysts International*, March 11, 2009.

[144] Francis Peters, "E-payments and E-tailing: Growth Of Retail E-commerce In China," *China Tech News,* March 13, 2008, http://www.chinatechnews.com/2008/03/13/6491-e-payments-and-e-tailing-growth-of-retail-e-commerce-in-china.

[145] It is worth noting that each country counts e-commerce slightly differently, so direct comparisons should be taken with a grain of salt.

[146] Castro, Bennett, and Andes, "Steal These Policies: Strategies for Reducing Digital Piracy."

[147] OECD, The Future of the Internet Economy: A Statistical Profile.

[148] Ibid.

[149] Alexa, "Top Sites by Country."

[150] Ministry of Economy, Trade, and Industry, "Collaboration for Overcoming National Challenges," 2007, http://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2009/chapter3-2.pdf.

[151] Ian McKee, "Social Networking in Asia Takes Off," The Power of Influence blog, February 21, 2009, http://thepowerofinfluence.typepad.com/the_power_of_influence/2009/02/social-netorking-in-asia-takes-off.html.

[152] Ibid.

[153] OECD, Communications Outlook 2009.

[154] United Nations Conference on Trade and Development (UNCTAD), *Information Economy Report 2009*, http://www.unctad.org/en/docs/ier2009_en.pdf.

[155] Martha Chen, "Women in the Informal Sector: A Global Picture, the Global Movement," *SAIS Review* (XXI), 1, 2001.

[156] UNCTAD, *Global Information Society: A Statistical View*, April 2008, http://www.unctad.org/en/docs//LCW190_en.pdf.

[157] Ibid.

[158] ACNielsen, "Global Consumer Attitudes Towards Online Shopping," October 2005, http://jp.en.nielsen.com/news/documents/OnlineShoppingTrends_05.pdf.

[159] Ibid.

[160] John Humphrey, Robin Mansell, Daniel Pare, and Hubert Schmitz, "The Reality of E-commerce with Developing Countries," The London School of Economics, March 2003, http://www.lse.ac.uk/collections/media@lse/pdf/Report.pdf.

[161] UNCTAD, Information Economy Report 2009.

[162] Tim Ogilvie, "Business Model (r)Evolution Project," Tim Ogilvie's Blog, September 4, 2009, http://www.timogilvieblog.com/2009/09/business-model-revolution-project.html.

[163] Tekes, "Seizing the White Space," 13.

[164] Tekes, "Seizing the White Space."

[165] Adapted from Peer Insight, "The Six Secrets of Business Model Exploration," April 2008, http://www.peerinsight.com/bizmodelinnovation.php.

[166] Wharton School, University of Pennsylvania, "Rethinking the Long Tail Theory: How to Define 'Hits' and 'Niches'," *Knowledge at Wharton*, September 16, 2009, http://cacm.acm.org/news/42525-rethinking-the-long-tail-theory-how-to-define-hits-and-niches/fulltext.

[167] Erik Brynjolfsson, Yu "Jeffrey" Hu, and Michael D. Smith, "From Niches to Riches: The Anatomy of the Long Tail," *Sloan Management Review*, 47, no. 4 (Summer 2006): 67-71, http://www.heinz.cmu.edu/~mds/smr.pdf.

[168] Erik Brynjolfsson, Yu "Jeffrey" Hu, and Michael D. Smith, "Consumer Surplus in the Digital Economy: Estimating the Value of Increased Product Variety at Online Booksellers," MIT Sloan School of Management, MIT Sloan Working Paper No. 4305-03, June 2003, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=400940.

[169] Michael Arrington, "3 Million Amazon Kindles Sold, Apparently," TechCrunch.com, January 29, 2010, http://techcrunch.com/2010/01/29/3-million-amazon-kindles-sold-apparently/.

[170] Tim Conneally, "Amazon CEO: We sell 6 Kindle books to every 10 books," BetaNews, January 29, 2010, http://www.betanews.com/article/Amazon-CEO-We-sell-6-Kindle-books-to-every-10-books/1264781064.

[171] Robert Hof, "Who Needs Blockbusters," *BusinessWeek*, July 17, 2006, 88, http://www.businessweek.com/magazine/content/06_29/b3993104.htm.

[172] Ibid.

[173] Ibid.

[174] NetJets.com, "About NetJets," http://www.netjets.com/ABOUT_NETJETS/about_netjets.asp.

[175] FlexJet.com, "Compare Solutions," http://www.flexjet.com/Compare-Solutions/index.html.

[176] Couchsurfing.com, "About-Statistics," http://www.couchsurfing.com/statistics.html. The site claims 1,688,295 members in 235 countries and 70,560 cities.

[177] Jean V. Murphy and Kurt C. Hoffman, "Logistics Exchanges By Any Other Name Still Can Save Shippers Money," *Global Logistics and Supply Chain Strategies*, Keller International Publishing, April 2001. Can be accessed with log-in at: http://jobfunctions.bnet.com/abstract.aspx?docid=77042.

[178] Getloaded.com, "The Internet Load Board for the Trucking Industry," http://www.getloaded.com.

[179] R. Glenn Hubbard, Statement made at: "Productivity in the 21st Century," (Productivity Conference), October 23, 2002, Hosted by: United States Department of Labor's Office of the 21st Century Workplace and the American Enterprise Institute.

[180] Tekes, "Seizing the White Space," 64.

[181] Ajit Kambil and Vipul Agrawal, "E-commerce: The New Realities of Dynamic Pricing," *Accenture Outlook Journal*, July 2001, http://www.accenture.com/Global/Research_and_Insights/Outlook/By_Alphabet/EcommercePricing.htm.

[182] eBay, "Who We Are," http://www.ebayinc.com/who.

[183] Ravi Bapna, Wolfgang Jank, and Galit Shmueli, "Consumer Surplus in Online Auctions," Information Systems Research, 19, no. 4, (December 2008): 400-416, http://www.rhsmith.umd.edu/faculty/wjank/consumerSurplusOnlineAuctions.pdf.

[184] Pefa.com, "About Pefa," http://www.pefa.com/en/about-pefa.html.

[185] Chemconnect, Inc., "About ChemConnect," http://www.chemconnect.com/about.html.

[186] eBay, "New Study Reveals 724,000 Americans Rely on eBay Sales for Income," July 21, 2005, http://investor.ebay.com/releasedetail.cfm?releaseid=170073.

[187] Askville by Amazon, "Eight million people use Amazon to sell books," January 30, 2009, http://askville.amazon.com/million-people-Amazon-sell-books/AnswerDetails.do?requestId=54060884&responseId=54819507.

[188] Tekes, "Seizing the White Space," 56-57.

[189] Tekes, "Seizing the White Space," 58.

[190] Alfredo Gutierrez, "e-business on demand: A developer's roadmap," IBM developerWorks, February 17, 2003, http://www.ibm.com/developerworks/ibm/library/i-ebodov/index.html.

[191] Grid Computing Information Center, "Grid Computing Info Centre (GRID Infoware)," http://www.gridcomputing.com/.

[192] Gartner, "Gartner Says Cloud Computing Will Be As Influential As E-business," June 26, 2008, http://www.gartner.com/it/page.jsp?id=707508.

[193] Amazon.com, "Amazon Simply Storage Service (Amazon S3)," http://aws.amazon.com/s3/.

[194] Deighton and Quelch, Economic Value of the Advertising-Supported Internet Ecosystem.

[195] Wharton School, University of Pennsylvania, "Rethinking the Long Tail Theory."

[196] Rob Walker, "Mass-Produced Individuality," *New York Times Magazine*, December 11, 2005, 34, http://www.nytimes.com/2005/12/11/magazine/11wwln_consumed.html.

[197] Caterist.org, http://www.cater-ist.org/index.php?p=home#pc.

[198] Robert Atkinson and Mark Cooper, "A cure by way of the consumer," *Washington Times,* December 17, 2008, http://www.washingtontimes.com/news/2008/dec/17/ailing-auto-industry/.

[199] Jim Strothman, "'Build to order' marching in," *InTech,* May 1, 2002, http://www.isa.org/InTechTemplate.cfm?Section=InTech&template=/ContentManagement/ContentDisplay.cfm&ContentID=13306.

[200] G. T. Lumpkin and Gregory G. Dess, "E-Business Strategies and Business Models: How the Internet Adds Value," *Organizational Dynamics*, 33, no. 2 (May 2004): 161.

[201] Loren Gray, "Dow's Push for Organic Growth," *Harvard Business Review,* November 15, 2004.

[202] Dow Corning, "Harvard Business Review Features XIAMETER® Business Model," March 10, 2009, http://www.dowcorning.com/content/news/XIAMETER_businessmodel_featured_in_HBR.asp.

[203] Concord Law School, http://www.concordlawschool.edu/.

[204] National Center for Education Statistics, "Fast Facts," http://nces.ed.gov/fastfacts/display.asp?id=80.

[205] U.S. Distance Learning Association, "United States Distance Learning Association and Elluminate, Inc. Partner to Launch New Website," February 5, 2009, http://archive.constantcontact.com/fs016/1011054872119/archive/1102411801568.html.

[206] Cisco Systems, "Cisco Guide to Buying Network Managed Services," 2004, http://www.ciscosystems.to/en/US/solutions/collateral/ns340/ns414/ns465/net_brochure0900aecd8019efd7.pdf.

[207] Ibid.

[208] Kevin Johnson, Microsoft, filing to the Security Exchange Commission (SEC) of Microsoft Employee Web Cast, Commission File No.: 000-28018, February 1, 2008, http://sec.gov/Archives/edgar/data/789019/000095012308001107/y47867de425.htm.

[209] Deighton and Quelch, Economic Value of the Advertising-Supported Internet Ecosystem, 40.

[210] Jessica E. Vascellaro, "Russian Firm Offers to Invest in Facebook," *Wall Street Journal,* May 23, 2009, http://online.wsj.com/article/SB124303553603348803.html?mod=googlenews_wsj.

[211] Lumpkin and Dess, "E-Business Strategies and Internet Business Models," 8.

[212] Ibid.

[213] Tekes, "Seizing the White Space," 15.

[214] Erik Brynjolfsson and Adam Saunders, "Introduction," ch.1 in *Wired for Innovation: How Information Technology is Reshaping the Economy* (Boston, Massachusetts: MIT Press, 2010), http://mitpress.mit.edu/books/chapters/0262013665intro1.pdf.

[215] Lumpkin and Dess, "E-Business Strategies and Business Models."

[216] Chiara Criscuolo and Kathryn Waldron, "E-commerce and Productivity," *Economic Trends 600*, U.K. Office of National Statistics, November 2003, 52-57, http://www.statistics.gov.uk/articles/economic_trends/ETNov03Criscuolo.pdf.

[217] Donald A. Johnston, Michael Wade, and Ron McClean, "Does E-Business Matter to SMEs? A Comparison of the Financial Impacts of Internet Business Solutions on European and North American SMEs," *Journal of Small Business Management*, 45, no. 3 (July 2007): 354-361. In 2007, U.S. manufacturers invested approximately 2 percent of revenue in IT (including Internet-enabled solutions) leading to sales. (See *Information Week*, October 27, 2007.)

[218] Hal Varian, Robert E. Litan, Andrew Elder, and Jay Shutter, "The Net Impact Study: The Projected Economic Benefits of the Internet In the United States, United Kingdom, France, and Germany, Version 2.0," January 2002, http://www.netimpactstudy.com/NetImpact_Study_Report.pdf.

[219] Total e-commerce from .com domains is based on global estimates after subtracting Web-based e-commerce across other top level domains as well as non-Web based e-commerce that occurs through Electronic Data Interchange (EDI). Eurostat reports that non-Internet e-commerce makes up 60 percent of total e-commerce turnover in Europe, and from this a global average is extrapolated. In order to estimate percent of Web-based e-commerce that comes from .com domain names, total Web-based e-commerce was divided by the percentage of top level domain names that are .coms in each country.

[220] Global sales of medicine are approximately $780 billion, investment in renewable energy $400 billion, and government R&D $300 billion.

[221] Robert Atkinson, "Buying Contact Lenses Online: A Critique of the Fogel and Zidile Optometry Journal Study," Information Technology and Innovation Foundation, July 2006, http://www.itif.org/files/2008contactlenses.pdf.

[222] Atkinson and Cooper, "A cure by way of the consumer."

[223] Xing Pan, Venkatesh Shankar, and Brian T. Ratchford, "Price Competition Between Pure-play vs. Bricks-and-Clicks e-Tailers: Analytic Model and Empirical Analysis," University of Maryland Robert H. Smith School of Business, June 2002, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=328840.

[224] Erik Brynjolfsson, Astrid A. Dick, and Michael D. Smith, "Search and Product Differentiation on an Internet Shopbot," MIT Sloan School of Management, MIT Sloan Working Paper No. 4441-03, October 2003, http://ebusiness.mit.edu/research/papers/194A_Brynjolfsson_Internet_Shopbot.pdf.

[225] Consumer surplus is defined by the difference between the total value consumers get from a good or service and the actual price they pay. See Jeffrey R. Brown and Austan Goolsbee, "Does the Internet Make Markets More Competitive? Evidence from the Life Insurance Industry," *Journal of Political Economy*, 110, no. 3 (2002): 481-507, http://www.journals.uchicago.edu/doi/abs/10.1086/339714?journalCode=jpe.

[226] Michael Smith, Joseph Bailey, and Erik Brynjolfsson, "Understanding Digital Markets: Review and Assessment," in *Understanding the Digital Economy: Data, Tools, and Research*, ed. Erik Brynjolfsson and Brian Kahin (Cambridge, Massachusetts: MIT Press, 2002).

[227] Mary Madden, "Data Memo: Internet Penetration and Impact," Pew Internet & American Life Project, data memo, April 2006, http://www.pewinternet.org/~/media/Files/Reports/2006/PIP_Internet_Impact.pdf.pdf.

[228] Lu Chen and Joel Waldfogel, "Does Information Undermine Brand? Information Intermediary Use and Preference for Branded Web Retailers," National Bureau of Economic Research, Working Paper 9942, August 2003, http://www.nber.org/papers/w9942.

[229] Accenture, "U.S. Consumers Increasingly Going Online and Calling Stores to Research Product, Availability, and Price Accenture Survey Finds," April 4, 2007, http://newsroom.accenture.com/article_display.cfm?article_id=4529.

[230] Mark Boslet, "Google Tests New Action-Based Ads," *Wall Street Journal Online*, June 22, 2006.

[231] Robert Atkinson, "'Turbo-Government': A Bold New Vision for E-Government," Information Technology and Innovation Foundation, September 2006, http://www.itif.org/files/turbogov.pdf.

[232] Martin Fackler, "In Japan, Day-Trading Like It's 1999," *New York Times*, February 19, 2006, http://www.nytimes.com/2006/02/19/business/yourmoney/19day.html?_r=1.

[233] Atkinson, The Past and Future of America's Economy, 165.

[234] James E. Prieger and Daniel Heil, "The Microeconomic Impacts of E-Business on the Economy," May 20, 2009, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1407713.

[235] American Society of Travel Agents, "Frequently Asked Questions," http://www.asta.org/News/content.cfm?ItemNumber=1985.

[236] comScore, "2009 US Digital Year In Review."

[237] Office of Management and Budget, Executive Office of the President of the United States, "FY 2004 Report to Congress on Implementation of the E-Government Act of 2002," March 1, 2005, http://www.whitehouse.gov/omb/inforeg/2004_egov_report.pdf.

[238] National Association of Realtors, "NAR Home Buyer and Seller Survey Shows Rise in First-Time Buyers, Long-Term Plans," November 8, 2008, http://www.realtor.org/press_room/news_releases/2008/11/home_buyer_and_seller_survey_shows.

[239] Alice Dragoon, "Nice Doing Business With You," *CIO Magazine*, February 15, 2005, http://www.foley.com/files/tbl_s38News/FileUpload257/1184/eva_selfserve.pdf.

[240] Chris Anderson, "People Power," *Wired*, 14.07, July 2006, http://www.wired.com/wired/archive/14.07/people.html.

[241] Christopher M. Schroeder, "Is This the Future of Journalism?" *Newsweek*, June 18, 2004, http://www.newsweek.com/id/53873.

[242] For example, see Pacific Business Group on Health, "Advancing Physician Performance Measurement," Lumetra, September 2005, http://www.pbgh.org/programs/documents/PBGHP3Report_09-01-05final.pdf#search=%22online%20benchmarking%20consumer%20quality%22.

[243] Randall Stross, "AOL Said, 'If you Leave Me I'll Do Something Crazy,'" *The New York Times,* July 2, 2006, http://www.nytimes.com/2006/07/02/business/yourmoney/02digi.html?pagewanted=print.

[244] Barry Schwartz, *The Paradox of Choice: Why More Is Less* (New York: Ecco, 2003).

[245] Chris Anderson, The Long Tail: Why the Future of Business is Selling Less of More (New York: Hyperion, 2006).

[246] Robert D. Atkinson and Andrew W. McCay, *Digital Prosperity: Understanding the Economic Benefits of the Information Technology Revolution*, Information Technology and Innovation Foundation, March 2007, http://www.itif.org/files/digital_prosperity.pdf.

[247] Lumpkin and Dess, "How the Internet Adds Value," 164.

[248] Ibid.

[249] Charles Phillips and Mary Meeker, "The B2B Internet Report: Collaborative Commerce," Morgan Stanley Dean Witter, Equity Research North America, April 2000, http://path.berkeley.edu/~raja/distributed-server/msdwb2b/b2bp1a.pdf.

[250] Criscuolo and Waldron, "E-commerce and Productivity."

[251] There is also significant potential in the $2.1 trillion construction industry. Daily collaborations among contractors, engineers, architects, and suppliers are based on large amounts of paperwork. Companies such as Bidcom, Bricsnet.com, and Cephren have collaboration tools that track project specs, enabling reduced cost and fewer errors.

[252] Hal Varian *et al.*, "The Net Impact Study."

[253] Irene Bertschek, Helmut Fryges, and Ulrich Kaiser, "B2B or Not to Be: Does B2B E-Commerce Increase Labor Productivity?" Center for European Economic Research, Discussion Paper No. 04-45, http://econstor.eu/bitstream/10419/24055/1/dp0445.pdf.

[254] Philipp Koellinger, "Impact of ICT on Corporate Performance, Productivity, and Employment Dynamics," European Commission, Special Report No. 01/2006, December 2006, http://www.ebusiness-watch.org/studies/special_topics/2006/documents/TR_2006_ICT-Impact_I.pdf. (See exhibits 2 and 3.)

[255] Juha-Miikka Nurmilaakso, "ICT solutions and labor productivity: evidence from firm-level data," *Electronic Commerce Research,* 9, no. 3 (September 2009), http://www.springerlink.com/content/vnl8631556q78803.

[256] Arthur Grimes, Cleo Ren, and Philip Stevens, "The Need for Speed: Impacts of Internet Connectivity on Firm Productivity," Motu Economic and Public Policy Research, Motu Working Paper 09-15, October 2009, http://motu-www.motu.org.nz/wpapers/09_15.pdf.

[257] B. K. Atrostic and Sang Nguyen, "IT and Productivity in US Manufacturing: Do Computer Networks Matter?" *Economic Inquiry*, 43, issue 3 (2005): 493-506, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=906247.

[258] Mika Maliranta and Petri Rouvinen, "Productivity effects of ICT in Finnish business," Research Institute of the Finnish Economy, Discussion paper No. 852, 2003, http://www.etla.fi/files/674_dp852.pdf.

[259] H.O. Hagén and J. Zeed, "Does ICT use matter for firm productivity?" in *Yearbook on Productivity 2005*, Statistics Sweden, 2005.

[260] Hagén *et al.,* "Innovation matters: An empirical analysis of innovation 2002–2004 and its impact on productivity," *Yearbook on Productivity 2007*, Statistics Sweden, http://www.scb.se/statistik/_publikationer/OV9999_2007A01_BR_00_X76BR0801.pdf.

[261] Luis Garicanao and Steven N. Kaplan, "The Effects of Business-to-Business E-Commerce On Transaction Costs," University of Chicago, Graduate School of Business, July 2001, http://faculty.chicagobooth.edu/steven.kaplan/research/gk.pdf.

[262] Roman Beck, Rolf Wigand, and Wolfgang Konig, "Integration of E-Commerce by SMEs in the Manufacturing Sector," *Journal of Global Information Management*, 13, no. 3 (July-September 2005): 20-32, http://www.infosci-journals.com/downloadPDF/pdf/ITJ2901_fXBcKLEGfc.pdf.

[263] J. Ruiz-Mercader, A. L. Meroño-Cerdan, and R. Sabater-Sánchez, "Information technology and learning: Their relationship and impact on organisational performance in small businesses," *International Journal of Information Management*, 26, no. 1 (2005): 16-29.

[264] Johnston, Wade, and McClean, "Does E-Business Matter to SMEs?"

[265] Johnston, Wade, and McClean, "Does E-Business Matter to SMEs?" 361.

[266] Chris Forman, Avi Goldfarb, and Shane Greenstein, "The Internet and Local Wages: Convergence or Divergence?" National Bureau of Economic Research, Working Paper No. 14750, February 2009, http://www.rotman.utoronto.ca/agoldfarb/internet_wages.pdf.

[267] Hung-Hao Chang and David R. Just, "Internet Access and Farm Household Income—Empirical Evidence using a Semi-parametric Assessment in Taiwan," *Journal of Agricultural Economics*, 60, issue 2 (2009): 348-366, http://www.ingentaconnect.com/content/bpl/jage/2009/00000060/00000002/art00006?crawler=true.

[268] Paul DiMaggio and Bart Bonikowski, "Make Money Surfing the Web? The Impact of Internet Use on the Earnings of U.S. Workers," *American Sociological Review*, 73, no. 2 (April 2008): 227-250, http://www.ingentaconnect.com/content/asoca/asr/2008/00000073/00000002/art00003.

[269] Carr, "Does IT Matter?"

[270] J. Efendi, M. R. Kinney, and L. M. Smith, "Technology and profitability: Did B2B buy-side e-commerce systems improve financial performance?" Texas A&M University, unpublished manuscript, 2007.

[271] Johnston, Wade, and McClean, "Does E-Business Matter to SMEs?" 361.

[272] Atkinson and McCay, *Digital Prosperity*, 45.

[273] Ashok K. Mishra, Robert P. Williams, and Joshua D. Detre, "Internet Access and Internet Purchasing Patterns of Farm Households," *Agricultural and Resource Economics Review*, 38, issue 2 (2009), http://ageconsearch.umn.edu/handle/55545.

[274] Maris Goldmanis *et al.*, "E-Commerce and the Market Structure of Retail Industries," National Bureau of Economic Research, Working Paper No. W14166, July 2008, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1161089.

[275] Anna Thibodeaux, "Granny B Goes Global," BusinessReport.com, June 2, 2008, https://www.businessreport.com/news/2008/jun/02/granny-b-goes-global-tchn1/.

[276] Shane W. Mathews, "Internetalisation: the Internet's influence on international market growth in the firm's outward internationalisation process," Queensland University of Technology, thesis, 2009, http://eprints.qut.edu.au/29979/.

[277] Pierre Hadaya and Robert Pellerin, "Understanding the role of virtual enterprises in supporting manufacturing SMEs' internationalisation process," *International Journal of Globalisation and Small Business*, 2, no. 3 (2008): 262-279, http://inderscience.metapress.com/app/home/contribution.asp?referrer=parent&backto=issue,2,6;journal,5,11;linkingpublicationresults,1:112374,1.

[278] George R. G. Clarke and Scott Wallsten, "Has the Internet Increased Trade? Developed and Developing Country Evidence," *Economic Inquiry*, 44, issue 3 (2006): 465-484, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1095593.

[279] Silvana Trimi, Silvana Faja, and Shanggeun Rhee, "Impact of the Internet on interorganizational Relationships," *Service Business*, 3, no. 1 (March 2009), http://www.springerlink.com/content/9nh3925008762161/fulltext.pdf.

[280] Subhash Bhatnagar and Nitesh Vyas, "Gyandoot: Community-Owned Rural Internet Kiosks," World Bank, January 8, 2001, http://Web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTINFORMATIONANDCOMMUNICATIONANDTECHNOLOGIES/EXTEGOVERNMENT/0,,contentMDK:20486032~menuPK:1767268~pagePK:210058~piPK:210062~theSitePK:702586,00.html.

[281] Ibid.

[282] Ibid.

[283] Jeremy Kahn, "Pounding Keys, Not Gavels, to Sell India's Tea," *The New York Times*, April 22, 2008, http://www.nytimes.com/2008/04/22/business/worldbusiness/22tea.html.

[284] P.D. Kaushik and Nirvikar Singh, "Information Technology and Broad-Based Development: Preliminary Lessons from North India," UC Santa Cruz Economics, Working Paper No. 522, July 2002, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=344830.

[285] Phillip Koellinger, "The Relationship between Technology, Innovation, and Firm Performance: Empirical Evidence on E-Business in Europe," ERIM Report series in Research in Management, Reference No. ERS-2008-031-ORG, May 26, 2008, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1328204.

[286] Eric Von Hippel, *Democratizing Innovation* (Cambridge, Massachusetts: MIT Press, 2005).

[287] Zero Prestige Mega-Corporation, "The Kiteboard Cookbook," http://www.mit.edu/people/robot/zp/zeroprestige.html.

[288] William C. Taylor, "Here's an Idea: Let Everyone Have Ideas," *The New York Times*, March 26, 2006, http://www.nytimes.com/2006/03/26/business/yourmoney/26mgmt.html.

[289] Michelle Bishop, "The Total Economic Impact of InnoCentive Challenges," Forrester Consulting, May 2009, http://www.innocentive.com/_assets/pdfs/tei_of_inno_ch101309.pdf.

[290] "InnovationJam 2008," IBM, http://www.ibm.com/ibm/jam/.

[291] Shan L. Pan and Dorothy E. Leidner, "Bridging Communities of Practice with Information Technology in Pursuit of Global Knowledge Sharing," *Journal of Strategic Management Systems*, 12 (2003): 71-88, http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VG3-473MFG0-1&_user=10&_coverDate=03%2F31%2F2003&_rdoc=1&_fmt=high&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=1212536849&_rerunOrigin=google&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=d4c659f4e114f59abffeb2561af779d9.

[292] Jeffrey T. Prince and Daniel H. Simon, "Has the Internet accelerated the diffusion of new products?" *Research Policy*, 38, issue 8 (2009): 1269-1277, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1316982.

[293] Betsey Stevenson, "The Internet and job search," in *Studies of labor market intermediation*, D. H. Autor, (Chicago, Illinois: University of Chicago Press, 2009).

[294] The Conference Board, "Job Seekers Use Both Print and Online Advertising," November 7, 2006, http://www.conference-board.org/UTILITIES/pressDetail.cfm?press_ID=3002.

[295] Prieger and Heil, "The Microeconomic Impacts of E-Business on the Economy."

[296] Arent Greve, Janet Salaff, and Elic Chan, "Immigrants and the Job Search: Comparing the Internet to Other Paths to Jobs," *Proceedings of the 40th Annual Hawaii International Conference on System Sciences*, 2007, http://www.chass.utoronto.ca/~salaff/Greve-etal_Internetjobs.pdf.

[297] In fact, a portion of this report was written by ITIF staff telecommuting from home during the great 2010 Washington, DC, snow blizzard.

[298] Sara Kiesler and Lee Sproull, "Public Volunteer Work on the Internet," in *Transforming Enterprise: The Economic and Social Implications of Information Technology,* William H. Dutton, Brian Kahin, Ramon O'Callaghan, and Andrew W. Wyckoff, eds. (Cambridge, Massachusetts: MIT Press, 2005), 361-374.

[299] Kristi Essick, "Help Wanted," *Wall Street Journal Online*, June 26, 2006.

[300] Ibid.

[301] D. B. Humphrey, M. Kim, and B. Vale, "Realizing the gains from electronic payments: Costs, pricing, and payment choice," *Journal of Money, Credit, and Banking*, 33, no. 2 (2001): 216-234, http://econ.haifa.ac.il/~kim/files/5.pdf.

[302] Kory Kroft and Devin G. Pope, "Does Online Search Crowd Out Traditional Search and Improve Matching Efficiency? Evidence from Craigslist," May 2008, http://opimweb.wharton.upenn.edu/documents/research/JPE_Final_with_figures.pdf.

[303] OECD, *OECD Information Technology Outlook 2008,* table 1.2, 2008, http://browse.oecdbookshop.org/oecd/pdfs/browseit/9308041E.PDF.

[304] OECD, OECD Information Technology Outlook 2008, table 1a1.7.

[305] Hamilton Consultants, Economic Value of the Advertising-Supported Internet Ecosystem.

[306] OECD, OECD Information Technology Outlook 2008, figure 5.10.

[307] OECD, OECD Information Technology Outlook 2008, 277.

[308] Deighton and Quelch, Economic Value of the Advertising-Supported Internet Ecosystem.

[309] Joshua Quitter, "Billions Registered," *Wired*, October 1994, http://www.wired.com/wired/archive/2.10/mcdonalds.html?pg=4&topic=&topic_set=.

[310] iWhois.com, "Top domain name sales chart," https://www.iwhois.com/sales/.

[311] Universal McCann, "Power to the People, Social Media Tracker: Wave.3," March 2008, http://www.goviral.com/articles/wave_3_20080403093750.pdf.

[312] John Markoff, "Microsoft Introduces Tool for Avoiding Traffic Jams," *The New York Times*, April 10, 2008, http://www.nytimes.com/2008/04/10/technology/10maps.html.

[313] Lynn M. Etheredge, "A Rapid-Learning Health System," *Health Affairs*, 26, no. 2 (2007): w107, http://content.healthaffairs.org/cgi/content/full/26/2/w107.

[314] Daniel Castro, "Explaining International IT Application Leadership: Health IT," Information Technology and Innovation Foundation, September 2009, 9, http://www.itif.org/files/2009-leadership-healthit.pdf.

[315] Kaiser Permanente, "Patients Eager to E-mail Their Doctors," press release, Oakland, California, July 15, 2007, http://ckp.kaiserpermanente.org/newsroom/national/archive/nat_070705_secure.html.

[316] Terhilda Garrido *et al.*, "Effect of Electronic Health Records in Ambulatory Care: Retrospective, Serial, Cross Sectional Study," *British Medical Journal*, 330 (2005): 1, http://www.bmj.com/cgi/content/abstract /330/7491/581.

[317] Yi Yvonne Zhou *et al.*, "Patient Access to an Electronic Health Record with Secure Messaging: Impact on Primary Care Utilization," *American Journal of Managed Care*, 13 (2007): 418-424.

[318] Susannah Fox, "Health Information Online," Pew Internet & American Life Project, May 17, 2005, http://www.pewinternet.org/Reports/2005/Health-Information-Online.aspx.

[319] Fisher-Price, "Online Learning Games from Fisher Price," http://www.fisher-price.com/fp.aspx?st=10&e=gamesLanding&mcat=game_infant,game_toddler,game_preschool&site=us.

[320] Ray Rivera and Andrew Paradise, "State of the Industry," American Society for Training & Development, 2006, http://www.astd.org/NR/rdonlyres/7EA9365D-709D-4C25-BDC8-42F55C2EC360/16910/2006SOIRFINAL.pdf.

[321] Joe Mullich, "A Second Act for E-Learning," *Workforce Management*, February 1, 2004, http://www.workforce.com/section/11/feature/23/62/89/index.html.

[322] Ed Frauenheim, "Your Co-Worker, Your Teacher: Collaborative Technology Speeds Peer-Peer Learning," *Workforce Management*, January 29, 2007, http://www.workforce.com/tools/reports/070129_SpecialReport_HRTech.pdf.

[323] Mary McCain, "E-Learning: Are We in Transition or Are We Stuck?" paper commissioned by the Center for Workforce Success of The Manufacturing Institute, an affiliate of the National Association of Manufacturers, March 11, 2008.

[324] I. Elaine Allen and Jeff Seaman, *Making the Grade: Online Education in the United States* (Needham, Massachusetts: The Sloan Consortium, 2006), 5.

[325] Yoany Beldarrain, "Distance Education Trends: Integrating New Technologies to Foster Student Interaction and Collaboration," *Distance Education*, 27, no. 2 (August 2006): 139.

[326] B. Veenhof *et al.*, "How Canadians' Use of the Internet Affects Social Life and Civic Participation," Statistics Canada, December 2008, http://chass.utoronto.ca/~wellman/publications/stats_can/statscan.pdf.

[327] Mary Madden and Amanda Lenhart, "Online Dating," Pew Internet & American Life Project, 2006, http://www.pewinternet.org/~/media//Files/Reports/2006/PIP_Online_Dating.pdf.pdf.

[328] Jeffrey Boase *et al.*, "The Strength of Internet Ties," Pew Internet & American Life Project, 2006, http://www.pewinternet.org/~/media//Files/Reports/2006/PIP_Internet_ties.pdf.pdf.

[329] Prosper, Prosper Web site, 2008, http://www.prosper.com/about/.

[330] Zopa, Inc., Zopa Web site, 2007, http://us.zopa.com/.

[331] Bruce Bimber, "The Internet and Political Fragmentation," excerpt from paper presented at Democracy in the 21st Century Conference, University of Illinois, Urbana-Champaign, Illinois, October 2004, http://www.polsci.ucsb.edu/faculty/bimber/polfragexcerpt.htm.

[332] Steven Levy, "See You Offline," *Newsweek*, May 29, 2006, http://www.newsweek.com/id/47962.

[333] George Pohle and Jeff Hitner, *Attaining Sustainable Growth Through Corporate Social Responsibility* (Somers, New York: IBM Global Business Services, 2008).

[334] Starbucks, "Corporate Social Responsibility," 2008, http://www.starbucks.com/aboutus/csr.asp.

[335] Pohle and Hitner, Attaining Sustainable Growth Through Corporate Social Responsibility.

[336] Vodafone, "Dialogue: Assurance of CR Reporting," 2008, http://www.vodafone.com/start/responsibility/cr_dialogues/dialogue_2_-_assurance.html.

[337] BP, LLC, "Environment and Society," 2008, http://www.bp.com/productlanding.do?categoryId=6913&contentId=7043155.

[338] Pohle and Hitner, Attaining Sustainable Growth Through Corporate Social Responsibility.

[339] Telis Demos, "Beyond the Bottom Line: Our Second Annual Ranking of Global 500 Companies," *Fortune*, October 2006, http://money.cnn.com/magazines/fortune/fortune_archive/2006/10/30/8391850/index.htm.

[340] Richard Boudreaux, "The Seeds of Promise," *Los Angeles Times*, April 16, 2006, http://www.latimes.com/business/careers/work/la-fg-remit16apr16,1,1053491.story?coll=la-headlines-business-careers.

[341] Richard Lapper, "Remittance Offer $301Bn Lifeline," *Financial Times*, October 18, 2007, http://www.ft.com/cms/s/0/9310bb5c-7ccb-11dc-aee2-0000779fd2ac.html.

[342] Ibid.

[343] Luis A. Castro and Victor M. Gonzalez, "Hometown Web sites: continuous maintenance of cross-border connections," in *Proceedings of the fourth international conference on Communities and technologies* (University Park, Pennsylvania: ACM, 2009), 145-154, http://portal.acm.org/citation.cfm?id=1556482.

[344] Michael Wesch, "You Tube Statistics," *Digital Ethnography @ Kansas State University Blog,* March 18, 2008, http://mediatedcultures.net/ksudigg/?p=163.

[345] Michael Arrington, "YouTube Video Streams Top 1.2 Billion/Day," TechCrunch.com, June 9, 2009, http://techcrunch.com/2009/06/09/youtube-video-streams-top-1-billionday/.

[346] comScore, "The 2009 U.S. Digital Year in Review."

[347] Daniel Castro, "Internet Radio and Copyright Royalties: Reforming a Broken System," Information Technology and Innovation Foundation, May 2007, http://www.itif.org/files/InternetRadio.pdf.

[348] K.C. Jones, "iTunes Boasts Second Place for Music Sales, Hits Milestones," *InformationWeek*, February 26, 2008, http://www.informationweek.com/news/internet/ebusiness/showArticle.jhtml?articleID=206900260.

[349] Apple, "iTunes Store Tops 10 Billion Songs Sold," Apple.com, February 25, 2010, http://www.apple.com/pr/library/2010/02/25itunes.html.

[350] Joseph P. Fuhr Jr. and Stephen B. Pociask, *Broadband Services: Economic and Environmental Benefits*, American Consumer Institute, October 31, 2007, 14, http://www.Internetinnovation.org/Portals/0/Documents/Final_Green_Benefits.pdf.

[351] John A. Laitner and Karen Ehrhardt-Martinez, *Information and Communication Technologies: The Power of Productivity,* American Council for an Energy-Efficient Economy, February 2008, http://www.aceee.org/pubs/e081.htm.

[352] Michael W. Toffel and Arpad Horvath, "Environmental Implications of Wireless Technologies: News Delivery and Business Meetings," *Environmental Science and Technology*, 38, no. 11 (June 2004): 2961, http://www.pubs.acs.org/cgi-bin/abstract.cgi/esthag/2004/38/i11/abs/es035035o.html.

[353] Ibid.

[354] Fuhr and Pociask, *Broadband Services*, 2007.

[355] Geoffrey R. Gerdes and Jack K. Walton II, "The Use of Checks and Other Noncash Payment Instruments in the United States," *Federal Reserve Bulletin*, 360 (August 2002), http://www.federalreserve.gov/pubs/bulletin/2002/0802_2nd.pdf and; Financial Services Policy Committee, Federal Reserve System, "Federal Reserve Studies Confirm Electronic Payments Exceed Check Payments for the First Time," press release, Minneapolis, Minnesota, December 6, 2004, http://www.federalreserve.gov/boarddocs/press/other/2004/20041206/default.htm.

[356] Scott Schuh, "Consumer Payment Choice: A Central Bank Perspective," Federal Reserve Bank of Boston, January 21, 2010, http://www.bos.frb.org/economic/cprc/presentations/2010/schuh012110.pdf.

[357] Joseph Romm, "The Internet and the New Energy Economy," Proceedings of the E-Vision 2000: Key Issues That Will Shape Our Energy Future Conference—Supplementary Materials: Papers and Analyses, CF-170/1-1-DOE (Arlington, Virginia: RAND, 2001): 137, http://www.rand.org/scitech/stpi/Evision/Supplement/romm.pdf.

[358] Brian Ratchford, Debabrata Talukdar, and Myung-Soo Lee, "The Impact of the Internet on Consumers' Use of Information Sources for Automobiles: A Re-Inquiry," *Journal of Consumer Research,* 34 (2007), http://www.journals.uchicago.edu/doi/abs/10.1086/513052.

[359] Pew Internet & American Life Project, "Daily Internet Activities, 2000-2009," http://www.pewInternet.org/Static-Pages/Trend-Data/Daily-Internet-Activities-20002009.aspx.

[360] Atkinson *et al.*, "The Need for Speed," 1.

[361] Acrossair, Acrossair Web site, 2010, http://www.acrossair.com/acrossair_app_augmented_reality_nearestsubway_newyork_for_iPhone_3GS.htm.

[362] Michael R. Nelson, "The Cloud, The Crowd, and the 3-D Internet: What's Next for Collaboration Online," presentation to National Defense University, April 24, 2009, http://www.ndu.edu/irmc/fcvw/fcvw10/images/2009/Apr24slides/nelson.pdf.

[363] Data for Turkey unavailable, so data for 29 of 30 OECD members shown.

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NOTES

NOTES

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This is an exciting time in human history. The future used to be something people had time to think about. Now it shows up every time we go online. At ITIF, we believe innovation and information technology are at the heart of our capacity to tackle the world's biggest challenges, from climate change to health care to creating more widespread economic opportunities. We are confident innovation and information technology offer the pathway to a more prosperous and secure tomorrow for all citizens of the planet. We are committed to advancing policies that enhance our collective capacity to shape the future we want - beginning today.

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The FCC tees up net neutrality

December 3rd, 2010 | by jz | Published in **Future of the Internet**, **Generativity**, **net neutrality** | **3 Comments**

A few months ago it looked like there'd be no action on net neutrality in the US by the FCC or Congress. After some momentum gathered during both the Bush and Obama administrations, a federal court ruling had cast doubt on the FCC's ability to regulate in the area, and a rancorous election season suggested this wouldn't find much room within Congress's agenda.

Then in September the FCC announced that its open Internet proceeding was **continuing**, and yesterday the commission's **agenda** for the December meeting suggests a vote in short order.

While the proposed rules are not yet publicly available, reports drawing from the chairman's **speech** yesterday and other talk in DC have something modeled on Congressman Henry Waxman's draft legislative **proposal**. The central plank is that broadband Internet service providers — at least non-wireless ones — must let their subscribers get where they want to go on the Internet. An ISP can't decide, say, that you're not to be allowed to get to facebook.com or that your service package doesn't permit streaming video or Internet telephony, each of which could conceivably compete with other services offered by the ISP, such as regular cable television or phone service.

It's good to have that off the table — it would be awful if ISP's started to do such things, and the prospect isn't as far-fetched as it might seem. An ISP might want to charge Facebook or Vimeo or some other content source for the privilege of reaching the ISP's subscribers, and the most direct way to do that is to threaten to halt the movement of bits from that source until a deal is reached. (This might look something like the recurring fights between the likes of **Cablevision and Fox** over showing the World Series, though in that case it was the content provider holding out for payment from the cable company. The risk that eager fans might not get to see baseball resulted in calls for FCC and Congressional intervention.)

With a net neutrality rule in place, if a Web site's bits can't be stopped in the middle just on the basis of where they came from, the ISP can't threaten to come between the site and its users. The market alone may not be able to deal with this in the absence of a net neutrality rule, both because there isn't much competition for broadband at a given location and because it's good for people to have assurances ahead of time that sites they are beginning a relationship with — as they put photos on Flickr or stow mail on Gmail — won't suddenly be pulled out from under them, held ransom to extra payments either from the sites or from them.

The telcos and other ISPs seem reconciled to this prospect, at least for wired networks. Now's the time to lock that in, when such holdups are not central to their business models — not by source, at least — and even application blocking has not historically been a core goal. (To be sure, five years ago at least one U.S. ISP **appeared** to be **blocking** an Internet telephony service, and it's happened **elsewhere** on a larger scale around the world.)

The FCC rules are said to exempt wireless from this mandate, instead simply requiring transparency about what's being blocked. **[Update:** A look at the FCC chairman's **speech** suggests there may be more than a transparency requirement for wireless; it mentions a "basic no blocking rule" there too. That would track the **Waxman bill** at p. 4 lines 1-7.**]** My reaction now is the **same as it was** when that division between wired and wireless was proposed as part of the Google/Verizon "framework" the two companies released in August. Basically:

> Some critics have said: who cares about network neutrality for regular broadband; wireless is the important part.
>
> I'm not so sure. If the framework had said the opposite — Verizon is OK with network neutrality for wireless but not for regular broadband — I can imagine many critics being just as upset, saying that wireless is still ancillary and that full broadband, with consumers' wi-fi attached, is what really matters. I guess they'd say that both matter. I'm skeptical myself of rules that carve a difference between them — one point of the Internet is to be medium-agnostic — but I'm less inclined to find an evil plan lurking in the differentiation. I can see that bandwidth management, at least, can be more crucial for wireless than wired at this stage in its development, and a Verizon might not feel comfortable having to justify any policies in those terms as an exception to a network neutrality rule. I'm less confident that there's robust competition in the wireless Internet space — there are still only a handful or providers, and switching among them is costly.

If a basic net neutrality mandate can be established for broadband — not only formally mandated by law (which includes FCC edict), but accepted as doable by the ISP's — that's good progress, and a metric against which the wireless ISPs will always be measured. Any protestations that they have to discriminate for the network's sake — or for the sake of a business model — will be increasingly belied by their wired counterparts' experiences under no-longer-controversial net neutrality rules. **[**And if the rule for wireless goes beyond the weak tea of Google/Verizon -- no-blocking as well as transparency -- that much the better.**]**

Another exception built in is for reasonable network management. Some critics have described this as a hole large enough to drive a truck through. But there has to be some kind of exception. The most obvious example is if a denial-of-service attack is in progress; there an ISP may refuse to carry bits precisely because of the content or purpose of the communication, discriminating by source, and no one would find that unacceptable. Should "reasonable" be stretched too far that could lead to trouble — but the alternative is to try to write down a more detailed set of technical requirements that might become stale very quickly. (I'm also no fan of Internet privacy legislation that makes specific reference, say, to "cookies.") This is exactly what a commission is for: to lay down principles, to stand by them, and then to adjudicate complaints under them with the benefit of transparency about what's going on. The ongoing **Level 3/Comcast dispute** is a great example of the utter rabbit hole of complexity — coupled with obscurity — surrounding some disputes over the movement of bits. There's no easy rule I can think of to anticipate it, much less resolve it, today. (And on that example, I hope to be part of a Berkman Center podcast next week exploring the topic as a way of thinking through just how unusual and not-fully-realized the economics of Internet connectivity are.)

Finally there is the question — abstruse to anyone who isn't a student of US telecom law — of whether the FCC should proceed under its "Title I" or "Title II" authority here. You can read some of the details in a guest post by Kevin Werbach at the FCC blog **here**. Essentially Title I is the weaker brew — so-called "ancillary authority" — and the FCC's use of it to advance the first round of net neutrality rules is what got it into trouble in the federal court ruling mentioned at the beginning of this post. Title II is stronger medicine, representing a claim to be able to more comprehensively regulate in the area, and ISPs have long rued the prospect of a reclassification of Internet services to Title II. I think whatever works … works. If this can happen with Title I, despite the D.C. Circuit ruling, great. If not — Title II remains a possibility. (Congressional action could clear all this up, of course, but it seems remote that Congress would wade into this once it reconvenes politically divided between House and Senate.)

I'll read the proposed rules with interest when they're released. In the meantime, the Chairman's speech shows the FCC knows what's at stake and is moving within a field of complex interests and claims to assure an Internet that's not cantonized, and that is open to new applications and content coming from anywhere, not just incumbents.

As part of a panel on net neutrality yesterday at Yale Law School with **Susan Crawford**, **Dawn Nunziato**, and **Nick Bramble**, I've drafted some general thoughts on why net neutrality matters. That should be up on a Yale site next week — I'll link to it or include a copy here once the essays are released.

Responses

Feed **Trackback Address**

1. ***Seth Finkelstein*** says:

   December 4th, 2010 at 2:28 am (#)

   How does "must let their subscribers get where they want to go on the Internet" interact with the Section 230 provision of:

   (2) Civil liability

   No provider or user of an interactive computer service shall be held liable on account of—

   (A) any action voluntarily taken in good faith to restrict access to or availability of material that the provider or user considers to be obscene, lewd, lascivious, filthy, excessively violent, harassing, or otherwise objectionable, whether or not such material is constitutionally protected; …

2. ***jz*** says:

December 4th, 2010 at 3:30 pm (#)

That's a great question — I've not heard anyone talk about CDA 230 in the context of net neutrality. Thinking aloud, "held liable" seems to suggest immunity in a tort case, not an interaction with the FCC and its authority to preserve an open Internet. But I can see how an ISP would say that any form of fine is civil liability.

Of course, it'd be hard for an ISP to say that it was blocking "in good faith" such stuff if the real motive were economic. But there is indeed plenty of objectionable material that is also lawful, and if one literally read the text without regard for the background to the CDA and its purposes — much of which is advertised in the preamble — it might well be thought to preclude an order preventing the blocking of certain sites by an ISP. An ISP that styled itself as kid-friendly might seek to claim exemption from net neutrality under 230.

What's your thought?

3. ***Seth Finkelstein*** says:

December 5th, 2010 at 2:41 am (#)

Well, this is the sort of situation where I say what I think doesn't matter, it's what a judge thinks that matters. But I'm wondering why it is that there isn't more discussion of CDA 230 in net neutrality debates, at least at the law/policy levels. Many of the most inflammatory content examples used – Verizon/abortion or ATT/Perl Jam – would seem fall squarely into that text of "objectionable, whether or not such material is constitutionally protected". Even the Comcast/P2P case could have worked up an argument that the vast majority of the material was copyright-infringing, and hence objectionable on that basis.

But when I ask net neutrality activists if they are repealing or overriding that part of CDA 230, it's very rare that they even seem to know what I'm talking about.

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- **Wikileaks FAQ**

I just finished recording a podcast with Larry Lessig and the Berkman fellows about Wikileaks. It should be online within a day or two. In the meantime, we've been trying to simply nail down some of the facts surrounding the situation. We figured we'd share what we've gathered so far as a FAQ, and we'll update it as we learn more or get corrections. Feel free to leave new questions in the comments and we'll aim to work those in too.

What is Wikileaks?

Wikileaks is a self-described "not-for-profit media organization," launched in 2006 for the purposes of disseminating original documents from anonymous sources and leakers. Its **website** says: "Wikileaks will accept restricted or censored material of political, ethical, diplomatic or historical significance. We do not accept rumor, opinion, other kinds of first hand accounts or material that is publicly available elsewhere."

More detailed information about the history of the organization can be found on **Wikipedia** (with all the caveats that apply to a rapidly-changing Wiki topic). Wikipedia incidentally has nothing to do with Wikileaks — both share the word "Wiki" in the title, but they're not affiliated.

Who is Julian Assange and what is his role in the Wikileaks organization?

Julian Assange is an Australian citizen who is said to serve as the editor-in-chief and spokesperson for Wikileaks since its founding in 2006. Previously he'd been described as an advisor. Sometimes he is cited as its founder. The media and popular imagination currently equate him with Wikileaks itself, with uncertain accuracy.

In 2006, Assange wrote a **series of essays** which have recently been tapped as an explanation of his political philosophy. A close reading of these essays shows that Assange's personal philosophy is in opposition to secrecy-based, authoritarian conspiracy governments, in which category he includes the US government amidst many others not conventionally thought of as authoritarian. Thus, as opposed to espousing a philosophy of radical transparency, Assange is not "**about letting sunlight into the room so much as about throwing grit in the machine.**" For further analysis, check out **Aaron Bady**'s original blog post.

Why is Wikileaks so much in the public eye right now?

At the end of November 2010, Wikileaks began to slowly release a trove of what it says are 251,287 diplomatic cables acquired from an anonymous source. These documents came on the heels of the release of the "Collateral Murder" video in April, and Afghan and Iraq War Logs in July and October, which totaled 466,743 documents. The combined 718,030 are said to originate from a single source, thought to be U.S. Army intelligence analyst Pfc. **Bradley Manning**, who was arrested in May 2010, but that's not confirmed.

Has Wikileaks released classified material in the past?

Yes, under an evolving set of models.

Berkman Fellow **Ethan Zuckerman** has some interesting thoughts on the development of Wikileaks and its practices over the years, which will be explained in greater detail when the Berkman Center podcast is released later this week. In the meantime, here's a capsule version.

Wikileaks has moved through three phases since its founding in 2006. In its first phase, during which it released several substantial troves of documents related to Kenya, Wikileaks operated very much with a standard wiki model: the public readership could actively post and edit materials and had a say in the types of materials that were accepted and how such materials were vetted. The documents released in that first phase were more or less a straight dump to the Web: very little organized redacting occurred on the part of Wikileaks. Wikileaks' second phase was exemplified with the release of the "Collateral Murder" video in April of 2010. The video was a highly curated, produced and packaged political statement. It was meant to illustrate a political point of view, not merely to inform. The third phase is the one we currently see with the release of the diplomatic cables: Wikileaks working in close conjunction with a select group of news organizations to analyze, redact and release the cables in a curated manner, rather than dumping them on the Internet or using them to illustrate a singular political point of view.

What news organizations have access to the diplomatic cables and how did they get them?

According to the **Associated Press**, Wikileaks gave four news organizations (**Le Monde**, **El Pais**, **The Guardian** and **Der Spiegel**) all 251,287 classified documents. The Guardian subsequently shared their trove with **The New York Times**.

So have all 251,287 documents been released to the public?

No. Each of the five news organizations is hosting the text of at least some of the documents in various forms with or without the relevant metadata (country of origin, classification level, reference ID). The Guardian and Der Spiegel have **performed** **analyses** of the metadata of the entire trove, excluding the body text. The Guardian's analysis is available for download from its **website**.

Wikileaks itself has released (as of 1:06pm on 7 December 2010) 960 documents out of the total 251,287. The **Associated Press has reported** that Wikileaks is only releasing cables in coordination with the actions of the five selected news organizations. Julian Assange made **similar statements** in an interview with Guardian readers on 3 December 2010. Cables are being released daily as the five news organizations publish articles related to the content.

Are each of the five news organizations hosting all the documents that Wikileaks has released?

No. Each of the five news organizations hosts a different selection of the released documents, in different forms, which may or may not overlap. It's not clear how much they're coordinating on releasing new documents, since each appears to have a full set.

How are the five news organizations releasing the cables?

Le Monde hosts an application, developed in conjunction with **Linkfluence**, which host the searchable text of several hundred cables. The text can be searched by the sender (either country of origin, office or official), date range, persons of interest cited in the docs, classification status, or any combination of the above. Only the untranslated, English text of the cables can be accessed and there is no cut-and-paste available.

El Pais offers access to over 200 cables, available in the orginal English or in Spanish translation, searchable by country of origin and key terms and subjects (such as "Google and China"). These searches also return *El Pais* articles written on a given subject (often places ahead of the cables in the search listings). They also offer a **"How to read a diplomatic cable"** feature, explaining what all the abbreviations and and technical verbage mean in plainspeak, posted on 28 November 2010.

The Guardian offers the cable data in several forms: they have performed an analysis of metadata of the entire 251,287 document trove, and made it available in several forms (spread sheets hosted on Google Docs and in downloadable form) as well as infographics.

The Guardian also hosts **at least 422 cables** on their website, searchable by subject, originating country and countries referenced.

The New York Times hosts what it calls a

> selection of the documents from a cache of a quarter-million confidential American diplomatic cables that WikiLeaks intends to make public starting on Nov. 28. A small number of names and passages in some of the cables have been removed by The New York Times to protect diplomats' confidential sources, to keep from compromising American intelligence efforts or to protect the privacy of ordinary citizens.

The documents are not searchable and are organized by general subject.

Who is responsible for redacting the documents? What actions did Wikileaks take to ensure that individuals were not put in danger by publication of the documents?

According to the **Associated Press** and statements released by **Wikileaks** and **Julian Assange**, Wikileaks is currently relying on the expertise of the five news organizations to redact the cables as they are released, and is following their redactions as it releases the documents on its website. (This cannot be verified without examining the original documents, which we have not done — nor are we linking to them here.) According to the **BBC**, Julian Assange approached the US State Department for guidance on redacting the documents prior to their release. One can imagine the dilemma for the Department there: assist and risk legitimating the enterprise; don't assist and risk poor redaction. In a **public letter**, Harold Koh, legal adviser to the Department of State, declined to assist the organization and demanded the return of the documents.

Are the documents hosted anywhere else on the Internet? What is the "insurance" file?

In late July 2010, Wikileaks **is said to have posted** to its Afghan War Logs site and to a torrent site an encrypted file with "insurance" in the name. The file, which apparently can still be found on various peer-to-peer networks, is 1.4 gigabytes and is encrypted with **AES256**, a very strong encryption standard which would make it virtually impossible to open without the password. What is in the insurance file is not known. It has been **speculated** that it contains the unredacted cables provided by the original source(s), as well as other, previously unreleased information held by Wikileaks. There is further speculation, which has been indirectly **boosted** by Julian Assange, that the key to the file will be distributed in the event of either the death of Assange or the destruction of Wikileaks as a functioning organization. However, none of these things is known. All that is known for sure is that it's a really big file with heavy encryption that's already in a number of people's hands and floating around for others to get.

What happens if Wikileaks gets shut down? Can it be shut down?

It depends on what's meant by "Wikileaks" and what's meant by "shut down."

Julian Assange has made statements suggesting that if Wikileaks becomes non-functional as an organization then the key to the encrypted "insurance" file will be released. The actual machination of how such a "**dead man's switch**" would operate is not known. If the key were released, and if the encrypted insurance file contains unredacted and unreleased secret documents, then those decrypted files would be available to many people nearly instantaneously. Wikileaks **claimed** in August that the insurance file had been downloaded over 100,000 times.

Wikileaks apparently maintains a small paid staff — who and where is not exactly on a "people" page, though there used to be a physical PO box in Australia where documents were solicited — and is additionally supported by volunteers, speculated to be at most a few thousand. So, would it be possible for a motivated organization to disrupt its real-world infrastructure? Yes, probably. However, at this point, it is not practical to recover the information the organization has already distributed (which includes the entire trove of diplomatic cables to the press as well as whatever is in the encrypted insurance file), as well as any other undistributed information the organization might seek to release. So in terms of the recovery of leaked information, the downfall of Wikileaks as an organization would matter little.

Furthermore, there appear to be currently over a thousand sites mirroring Wikileaks and its content. Wikileaks has made available downloadable files containing its entire archive of released materials to date.

On a more technical level, the Wikileaks website can come under attack, and its means of collecting money can be made much more difficult.

Why did wikileaks.org stop working as a way to find the site?

For a traditional website to work it will want a domain name like website.com, so people can find it. Those domain names can stop working for any number of reasons. One commonly assumed action for Wikileaks is that ICANN, the Internet Corporation for Assigned Names and Numbers that manages certain top-level protocol and parameter assignments for the Internet, intervened. It did not.

A little technical discussion to explain why: The domain name system ("DNS") is hierarchical, and its zones are exclusive of one another rather than inherited (save for the lateral mirroring among the twelve root zone servers). The root zone orchestrated by ICANN is a very small file — just a mapping between each top-level domain like .org or .ch ("TLD") and the IP address(es) of the servers designated to say more about that TLD (one server, not in ICANN's hands, keeps track of names under .org, one for names under .ch, etc.). You can see a user-friendly version of the file **here**, with the Swiss name servers described **here**. The info you see there is what ICANN can directly change — and that only for its own root zone servers (B, L, and sort-of A), hoping to have it mirrored by the others; map below the fold **here**.

So for those servers, ICANN could all-or-nothing delete .ch, which means for those drawing TLD info from the ICANN roots they'd eventually (depending on caching of previous info) cease finding the nic.ch server(s) in Switzerland through which to resolve any .ch name. But there's no way to express in the TLD zone something like "go to nic.ch for every domain name under .ch except wikileaks.ch." And if .ch were ditched, the mirroring root servers would likely balk at mirroring that elision, and ISPs using B, L, and A to resolve TLDs would just turn to other root zone servers — or hard code in the last known IP address for nic.ch as the place to go for .ch names.

I guess a too-crafty-by-half solution would be to mirror everything in the .ch zone to a new .ch server run by ICANN, then delete wikileaks.ch's info from that server's files, then redirect the root zone to the new server instead of the old. That would work for about five minutes. After that, increasing chaos as Swiss webmasters made changes to their .ch names in the "official" nic.ch registry only to find them not reflected for those users unlucky enough to be rerouted to ICANN's snapshot mirror. At which point the mirror roots (and the ISPs) awaken to the deception and take action a la the preceding graf.

Note that wikileaks.org went down not because of anything done to its DNS entry within the list kept by the **registry*** that minds the list of .org domains. Instead, the name server to which its entry pointed was attacked by unknown parties — DDOS'd — and **EveryDNS**, the operator of the name server, chose to stop answering queries about wikileaks in the hopes that the DDOS would stop. (Apparently it did.) EveryDNS is not to be confused with **EasyDNS**, which is a separate company that isn't involved in the situation!

*I'm on the board of Trustees for the non-profit **Internet Society**, ISOC, which is the parent to the **Public Interest Registry**, which keeps track of names in .org.

If a domain name doesn't work, a website can try to register and maintain another domain name, or it can just use a direct IP address — a number — to be found. A website also needs hosting, and Wikileaks has apparently had to shift its hosting at least once after being dropped by a chosen provider: Amazon's commodity hosting service **shut down the site** for terms of service violations after being contacted by U.S. Senator Joseph Lieberman.

- **The FTC's do-not-track list**

Yesterday the FTC announced a new project to encourage the formation of a "do-not-track" list, where Internet users could opt out of certain kinds of cookie-based Web tracking in one place and for good. The NYT room for debate blog asked for **reactions** –

> It's amazing to think that the sophistication and intensity of behavioral tracking technologies are primarily for the purpose of targeted advertising: giving dog food ads to dog owners, and homemade veggie burger ads to locavore vegans. All that borderline Orwellian machinery to … offer us stuff we might actually have interest in purchasing. What's more, if we click on an ad at a favorite Web site, we're sending money to that Web site. The more relevant the ad, the more clicks we make — and the more money we cause to be sent in support of the site we like. So I can see the worry of making opt-out so easy and permanent that people do it without another thought — and then injure the model that's bringing them free content.
>
> This feels different to me than a do-not-call list, which seems like an unambiguously good idea. There I'm opting out of getting bothered by sales calls while I'm eating dinner or reading a book. Those calls weren't underwriting the cost of my food or going to the author of my book. Do-not-track, on the other hand, doesn't opt out of getting ads at all, it just opts out of having them targeted. If do-not-call didn't affect how many calls I got — just whether I was getting pitched stuff I was likely to want — I'm not sure I would care one way or the other. I'd hang up on them all.
>
> Nonetheless I support some sort of global do-not-track system. That's because there are currently no functioning limits on what gets collected and how it is used, and the rise of cookie consortia like Doubleclick means otherwise-unrelated Web sites can all quietly serve as collection points for data about us that gets fed to a central source. If kept for long periods of time and not distilled, that data can prove as revealing about us as, say, our search engine histories. If the data is distilled — say, I'm targeted into old-fashioned advertising categories like "empty nester" or "college wannabe" — I'm much less concerned about its collection in order to better hone my placement.
>
> I'd couple opt-out with some helpful auditing tools. Let people see what's being collected about them and what impact it's having. For example, imagine a browser button that toggles between targeted and not-targeted, flipping back and forth between ads in the same space. Users may quickly get a sense of what they prefer, and if they can be assured that they can wipe everything clean at any time after checking out what's been gathered about them, they might be willing to let the data collection pay out a bit before deciding whether to pull the plug.
>
> The real nightmare scenarios to avoid are not better placed dog food ads. They have to do with varying price or service depending on undisclosed and long-collected behavior cues. Imagine if your wait for a customer service agent — and level of flexibility in making a return on a regrettable product purchase — depended on your overall purchasing (and product return) history across multiple merchants. Or if the price you were quoted (or coupons offered) at Amazon were a function of how quickly you click to purchase something at Etsy? (Those with known itchy trigger fingers don't get the discount, of course.) Or if your life insurance rates were grounded not just in openly collected facts like a medical checkup, but unexplained variances in what Web sites you elected to visit (backpacked across Europe, did you?).
> Bottom line: Web surfers get a bad deal right now; information is collected about them all over the place, and used in murky ways. Let's empower them

to know what's going on and opt out of practices they don't like, both prospectively and retroactively. Those options can be honed to eliminate abuses while still touting to people the products and services they want — and that fund the free content and services they already enjoy.

- **Uniflow is watching**

Several weeks ago, Canon **announced** that the latest version of its document management system, Uniflow 5, features a new security tool that allows a company to prevent its employees from printing, scanning, copying or faxing documents that contain keywords such as client or project names. The Uniflow server identifies prohibited keywords, which are designated by a central administrator, and blocks transmission of the offending document.

There are certainly reasons why this feature is worrisome. Uniflow blocks transmission of documents that use specific words, in effect selectively censoring the content of existing documents. In addition to preventing dissemination, Uniflow notifies an administrator, forwards the document at issue, and exposes the infringing employee's identity. These procedures give an employer all the evidence it needs to hold the employee responsible for illicit transmission. Finally, the power imbalance in an employer-employee relationship likely will make the employee overly cautious, in particular if her employer does not disclose the magic keywords that trigger Uniflow's alarm. In order to make sure she avoids disseminating sensitive documents, she may hesitate even when sending files she believes can be shared, because the cost to her if she is mistaken is too high to warrant the risk.

Nevertheless, I can also see Uniflow as an extension of employer email monitoring. Most employers have explicit technology policies that give employees notice that their work email belongs to the employer, who may monitor its contents. Therefore, workers don't have an expectation of privacy in their messages. If employers have a similar disclosure for company documents, Uniflow is simply the mechanism used for such monitoring. While keyword automation can lead to more extensive surveillance by decreasing the time and expense required to keep a close eye on employees, an employer often has good reason to control the dissemination of its sensitive documents. For example, employers should be able to regulate client information, legal advice, and intellectual property to protect against liability or loss of company assets. The documents do, after all, belong to the company. Can preventing circulation of its own speech really be labeled "censorship"? And Uniflow prevents only routine office transmission. A whistleblower, for example, can circumvent the security measure by taking pictures of relevant documents with his smartphone. So while Uniflow instinctively makes me uncomfortable, in general, I don't think its use will lead to untenable outcomes, at least in the workplace. (Use by governments, on the other hand, presents another question — as does government email surveillance.)

Instead, increasingly pervasive distributed surveillance is of **greater concern**. An employee knows that Uniflow is watching and can either print only documents she knows are keyword-free or avoid scrutiny by not using Canon machines if she thinks she is printing documents with prohibited keywords. In addition, she knows how her employer will use any information that it collects about her copying habits. But individuals often have no control over or even awareness of the personal information distributed observers digitally collect and publicize online. And once it is in the public sphere, they have no control over its use or further dissemination across the Internet. In addition to spreading information online, technology also facilitates sweeping data capture at both endpoints: collecting data to put online and collecting data from online sources. At one end surveillance casts a broad net; on the other it pans for gold.

In the employment context, consider an employee who called in sick to go to a World Series game. MLB **photographed the face of every fan** at the game and posted the panoramic composite image online (wide net), supported by Facebook Connect. A new **app** that runs on Facebook allows users to find photos of themselves and their friends and tag them automatically, so our hapless fan may be outed if one of his friends runs the software and his employer monitors — **directly** or **indirectly** — social media sites (gold).

The EU is currently grappling with this issue. It is **drafting** legislation that would give its citizens a right to remove personal data from websites. But in addition to difficulties enforcing EU law across an international Internet, the DMCA tack hasn't proven a particularly acclaimed copyright protection. While sites might be sympathetic to personal information takedown notices, identifying and contacting the totality of sites that have the data could be problematic. In the book, JZ **proposes** an alternative approach: engaging the Internet to disseminate the cure along with the disease by attaching metadata to personal information. Tagging personal information with the individual's request that his data not be posted publicly or copied or searchable (for example) attenuates its spread. In fact, Facebook implemented such an approach with its facial recognition tool. Automatic tagging includes not only the person's name but also the photo preferences he has set up on his Facebook account. So truant employees can control the dissemination of their photos after all. Sometimes you don't need mystery keywords or a centralized security system. All you have to do is ask.

—Jennifer Halbleib

- **FOI Topics and Links of the Week**

Google calls out Facebook. Last month, Facebook **added** an information download feature that made users' data portable. But there was one big exception. A user could download any content that he had uploaded or created — photos, wall posts, messages, etc.; however, he could only get a list of his friends, no contact information that would allow him to rebuild his social network easily elsewhere. Effectively, he could now sit alone in a room with all of his data. Google, which has always allowed its users and third parties (with the user's permission) to export contact information, put its foot down last week and changed its terms of service. Now sites have access to Google Contacts only if they are willing to reciprocate. So a user will have to export her contacts herself and then import them into Facebook, perhaps alerting her to Facebook's one-sided policy. While this change promotes fairness and openness in general, it doesn't take into account the possibility that some people use Facebook because it provides both contact with and a degree of separation from those in their social graph. Unlike a Google Contact, which is created when a user emails someone directly, Facebook users may friend people they wouldn't normally give their email addresses or phone numbers to, with the expectation that these friends can't batch download personal contact information. Facebook's policy may be tailored to respect such expectations, instead of being motivated by data protectionism, particularly given hits the company has taken in the past regarding user privacy. But a simple resolution of these conflicting interests — data portability and expectation of privacy — would allow a user to download the contact information of all his friends except those that have designated such information as private. The battles continue **here**.

For every smartphone, someone, somewhere has an app kill switch. This week, Microsoft discussed the circumstances in which its kill switch could be flipped on the Windows Phone. It emphasized that pre-screening apps and subsequent removal of any remaining risky apps from the Market Place were preferred tools for addressing privacy and security concerns, characterizing the kill switch as a scram in case of impending meltdown.

i(Gold)Bricks. An iPhone 3G user has accused Apple of a different type of killing. In a lawsuit filed last week, she alleges that Apple intentionally used the iOS 4 update to debilitate iPhone 3Gs in order to increase sales of the iPhone 4. Part of her claim is based on the charge that Apple didn't allow consumers to revert to a previous version of iOS after experiencing poor iOS 4 performance on an iPhone 3G — at least without voiding the warranty by jailbreaking the phone.

What are the limits on employee Internet policies? The NLRB is suing a Connecticut company, alleging that the employer fired one of its workers because she posted a negative comment about her supervisor on her Facebook page from her home computer. According the Legal Times, the NLRB is challenging a provision of the policy that the union says prohibits "depicting the company in any way over the Internet without company permission." The EMT service contends the woman was fired for "multiple serious issues."

A picture is worth a thousand dollars in traffic tickets. Next generation speed cameras not only calculate a driver's speed, but also check to see if his insurance is current, his seatbelt is on, and he's keeping a safe distance from the car in front of him. Some jurisdictions are apparently having difficulty making money off their speed cams. Upping the number of violations per picture should help.

Market Captcha. In the grand capitalist tradition of slapping an ad on any exposed surface, NuCaptcha is selling squiggly commercial space. Website visitors will have to type in a company slogan to proceed. Several prominent companies have signed up. I wonder if sellers of knock-off Rolexes and cheap pharmaceuticals will as well.

—Jennifer Halbleib

- **"… helpful to people in relationships where this type of monitoring can be useful."**

The NYT Bits blog **broke the story** of an Android app called the "SMS replicator." This odious piece of spyware is described **here**; unless it's a prank, the idea is that a stalker type with momentary access to someone else's Android phone can install it. It doesn't show up as an icon, but runs quietly in the background; any text messages are then forwarded to the stalker's phone too.

> Zak Tanjeloff, chief executive of the app's creator, **DLP Mobile**, said in a news release: "This app is certainly controversial, but can be helpful to people in relationships where this type of monitoring can be useful."

Controversial, indeed; I think it's awful and here I am spreading the word about it.

It was up in the Android app store until the NYT inquiry got it taken down. The company behind it didn't bother with a counterpart for the iPhone:

> Mr. Tanjeloff said in a phone interview that his company had decided to build the SMS application for the Android platform because it would not need to be reviewed before it reached users.
>
> "We can't build it for the iPhone because it wouldn't make it past the App Store approval process," Mr. Tanjeloff said.

Here, then, a certain generative trade-off, one I've described more with **viruses and trojans from afar** than a fellow phone-user's malice. With the iPhone, apps like these just aren't available — at least without the stalker having to jailbreak the targeted iPhone first. On the more generative Android, it's simply easier for bad stuff to brazenly find its way onto the platform since Google isn't as obsessed with curating the selection of software for the phone. And with Android, the official apps market isn't the only source for software — so the banning of SMS Replicator there doesn't exclude it from the phone; the enterprising stalker can install it from elsewhere.

Such software has been **available for a long time** on PCs, and few if any would say that its existence would be reason to upend the generative PC environment. But the competition between Android and iPhone highlights that generativity really does come with some costs. Should there be a well engineered Android worm that hops from phone to phone — either directly or by going through the SMS or email addressbook of each victim and recommending installation to the next — those costs will be even more drawn into focus, and the temptation may arise quickly to update Android not to be so open — or to exercise a kill switch targeting a particular piece of code.

It suggests the need, at least, for some easy-to-use auditing software for generative (or partially generative) platforms, Android, iPhone, and PC alike, so users can have a sense of what's going on inside the device — and what data is going in and out.

To be sure, the generative dilemma trading off openness and security interests me because it runs so deep. More superficial security problems can happen even on more locked down platforms, such as today's **revelation by Wired** that a quick key sequence can apparently bypass an iPhone's four-digit security code. iOS update no doubt soon to follow.

About Jonathan Zittrain

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Tweets from Z

- **FCC's net neutrality agenda is not ideal, but it's a glass more than half full http://futureoftheinternet.org/the-fcc-tees-up-net-neutrality**
- **RT @radioberkman: ATTN internet: Next week we're talking #wikileaks w/@lessig @zittrain & bright @berkmancenter minds. Tweet us any ques ...**
- **The FTC's new do-not-track Web surfing registry -- http://nyti.ms/hMTrUn**
- **Speaking at Yale Law today (minds for sale) http://tinyurl.com/287dry3 + tomorrow (net neutrality) http://yaleisp.org/?p=1985**

Blog Archives

Select Month

Telecommunications
Research Group
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Broadband Demand Study

Final Report

Michele Jackson

Tom Lookabaugh

Scott Savage

Douglas C. Sicker

Donald Waldman

University of Colorado at Boulder

November 15, 2002

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Introduction

Broadband penetration exceeds 10% of the U S population and continues to grow. But the rate of growth is itself particularly important to several constituencies. A general debate continues over the status of broadband adoption, the criticality of intervention, and which intervention policies would be effective. While much attention has historically been paid to the supply side of broadband, understanding and influencing the demand side of broadband is a key to understanding both status and appropriate policy.

This report examines a number of key attributes of demand for broadband. From a grounding in the definition and received knowledge on broadband demand, the report goes on to report research in consumer demand for broadband, small business and small office / home office demand, government use of broadband, telework, and international experience with broadband adoption. The research includes a new consumer survey including conjoint analysis of demand attributes and original interview based research on telework and its relation to broadband.

Key findings of the research include affirmation of the criticality of price in promoting the next stage of broadband adoption, the unexpected salience of reliability as a valued attribute, the importance of access speed, and the relatively lesser importance of ease of installation and security. The question of content and applications is complicated, with no killer application emerging but also no clear mandate to discover one. While the U. S. government could play a leadership role in adopting broadband, it does not appear to be in this role yet and may be most effectively involved by including broadband in its broader effort to incorporate information and communication technologies. Telework is a valid beneficiary of broadband, but, importantly, teleworkers are increasingly not technophiles and value broadband indirectly through the specific benefits it can bring to their productivity without being required to pay attention to the technology itself.

The report is organized into several sections. The next section of the report summarizes findings relative to the original research questions of the project. Following is a summary of the current state of the public debated on broadband demand and policy. We then report our consumer survey on broadband demand, followed by analysis of survey data on small business and small office / home office use of broadband. We next analyze government use of broadband, then report our analysis of a set of semi-structured interviews with teleworkers.

Findings Relative to Research Questions

In this section, we address the original research questions of the project.

1. *Why do residences and small businesses (less than 50 employees) that currently subscribe to narrowband Internet access services, and that are located in areas where broadband service is currently available, not subscribe? To what extent do the following inhibit subscription rates:*

   - and -

2. *For each of the items above, what are possible actions that would remove or ameliorate the barrier or concern?*

   a. *Awareness of service availability.*

   We had mixed results on awareness. In our consumer survey, awareness of high-speed service availability is relatively high for cable modem and DSL technology. When asked “which ways of getting high-speed access are available in your neighbourhood,” 15.3 percent of respondents replied “not sure” for cable modem, 30 percent for DSL, 64.7 percent for fixed wireless, and 68.2 percent for satellite. 80.6 percent of respondents with dial-up Internet access (i.e., latent high-speed users) have high-speed service available in their neighbourhood. Our telework survey suggested some confusion about availability of broadband (or even more fundamentally, exactly what broadband is). This confusion is also seen in some of our secondary research (various proponents of broadband don’t agree on the definition and surveys suggest various user communities have a diffuse understanding of the concept). These findings suggest that promoting awareness of service availability has some benefit, but it should be accompanied by substantial effort to clarify what broadband is and what it should mean to users (the benefits).

   b. *Price of the service.*

   Price is consistently a very important issue. In our consumer survey, the monthly cost of Internet access is very important for all survey respondents, but respondents with dial-up access place more importance on price than other attributes. Econometric estimates of marginal utilities show that dial-up users, and latent high-speed users, weight cost more heavily in their indirect utility functions than high-speed users. Our small business / SOHO analysis shows price to be the single largest perceived barrier to purchase of broadband service. Our telework research suggests that many teleworkers are responsible for part of their technology costs; price becomes an issue both for the teleworker and for the organization bearing the remainder of the costs. And our secondary research consistently suggests price is a critical issue and that significant price elasticity exists. These findings suggest (1) that actions intended to increase the perceived benefits of broadband can help (by justifying the price paid) and (2) it is not really feasible to ignore supply side issues to the extent they influence price.

c. *Price differential between broadband and narrowband services and perceived value differential.*

Our consumer survey suggests the price differential between dial-up and high-speed access, ($17.51 and $40.76 per month, respectively) is relatively high given many dial-up users place relatively low value on the "always on" attribute. Consumer surplus (i.e., willingness to pay, or WTP, less actual price paid) provides some understanding of perceived value. Econometric estimates of WTP suggest that latent high-speed users are willing to pay $26.35 to $35.19 for a very reliable high-speed service.[1] High-speed users, who tend to be "younger", more educated, and with higher income, are willing to pay $68.95 to $138.22 for a very reliable high-speed service. Assuming dial-up users currently have a reliable service, and given the mean price of high-speed access of $40.76, high-speed users clearly perceive greater value in high-speed access than latent high-speed users. Several strategies are available to attract the next wave of adopters: publicise and promote the benefits of broadband to the public; targeted education and promotion towards latent high-speed users (for instance, through one-stop shops that trial access, subsidized/free trials of broadband in the home, etc.; given that high speed users tend to be highly satisfied with their service once purchased, opportunities to trial the service at low or no cost should be particularly powerful); increase actual and/or perceived service reliability (this would place latent high-speed user's value closer to the range of actual monthly prices); and "version" Internet access by the reliability (or speed) attribute by identifying high-speed and latent high-speed groups (according to age, income, education, etc). For instance, provision of a "high-price", very reliable, high-speed service will satisfy high-value (high-WTP) customers, while a "low-price", less reliable, high-speed service will be a more attractive value proposition to latent high-speed users. Once latent high speed users experience high-speed service, and become more skilful in using speed and always on functionality, then some users within this group may self-select into the high-price/high-value service according to their revised WTP.[2]

[1] These figures are calculated by taking the monthly cost ($17.51) for low speed, very reliable, dial-up service that is not always on, and where installation is not important. Estimates of latent high-speed user's WTP are then incrementally added to this benchmark service to reflect a move from not always on to always on, and slow speed to fast, and fast to very fast.

[2] Versioning sells different quality services to different market segments at different prices. By creating low-quality (low-value) and high-quality (high-value) versions the firm can sell a good, which effectively costs the same to produce, at a higher price to consumers with significantly higher WTP. Whilst there is a social cost to reducing quality to satisfy the self-selection constraint, in many cases, the output effect appears to outweigh the quality reduction effect. Effectively, versioning can raise both firm profitability and societal welfare when new (low-

d. Concern about technical difficulty of installation.

Our consumer survey suggests that while many respondents state that installation is an important attribute of Internet access, they generally do not value it when trading-off other attributes in the utility maximization decision; similar our analysis of Small Business/SOHO data rates installation cost (a proxy for difficulty of installation) low as a barrier to purchase or as a reason for selecting a particular broadband provider. It appears that users are relatively willing to accept a "one time cost" in terms of installation difficulty – while there may be problems with installation, these do not appear This suggests that no particular action is required regarding ease of installation, but, ease of installation may nonetheless be subsumed in critical initiatives to increase ease-of-use and reliability discussed next.

e. Concern about technical difficulty of maintaining the service

f. Concern about delivered service meeting the advertised speeds and functionality (including availability, reliability, performance, ability to support multiple PCs, etc.)

g. Concern about service longevity based on recent industry bankruptcies, consolidations etc.

value) markets are served that would not be served in the absence of this pricing strategy.

In our consumer survey, e., f., and g. all refer to the same attribute – reliability of service. Both survey data and marginal utility estimates indicate that reliability of service is the *most important attribute* of Internet access. Consumers are WTP between $13.25 (Latent high-speed) and $39.12 (With high-speed) for more reliable service.

Our analysis of small business/SOHO data found that "low service reliability" is second only to price as a barrier to purchase of broadband. Further, our telework research suggests that teleworkers are increasingly not technophiles; they receive relatively little technical support from their organizations, and yet they are critically dependent on their technology (including their network connection). There appears to be an important potential to increase demand by using technical means to increase reliability, changing users' perceptions about reliability through advertising and education, service level agreements, and tiered access plans that differ according to service reliability (see d. above), and by structuring access to broadband services so as to increase reliability (for example, packaging technical support with broadband access to provide an integrated "high reliability" service to teleworkers).

h. Concern that the "always connected" nature of broadband services may introduce additional security concerns, or added complexity in implementing security measures

In our consumer survey, security aspects were eliminated from the questionnaire during pre-testing, so this question is not directly addressed. There were no comments about security in the 100 or so answers to the open ended question "please add any comments that would help us understand your answers to this survey?" Similarly, security was infrequently an issue in our semi-structured teleworker interviews. This is consistent with our secondary research, which suggests that consumers do not see increased security issues with "always on" as a substantial concern *for them* beyond their already existing concerns with, say, virus protection – the real cost is borne by businesses subject to distributed denial-of-service attacks. Similarly, security concerns rated low in our small business/SOHO analysis (well below monthly cost, service reliability, and equipment cost) as a barrier to broadband purchase, though concerns increase somewhat with the size of business. This finding does not support any strong initiatives to change perceived security risks in order to stimulate demand.

Separately, we note that "always on" is the third most important attribute in our consumer survey with WTP ranging from $0.91 (With dial-up) to $17.29 (With high speed). The low WTP for latent users is interesting; it suggests little appreciation for the impact of "always on" on lifestyle. By contrast, teleworkers have a clearer understanding of the benefit of "always on." Some of us speculate that "always on" may be a key but unperceived driver for the "stickiness" of broadband – the tendency for users to be satisfied and less likely to give up broadband once they have it. If this is true, it suggests the value of efforts to increase awareness of the benefits of "always on" and the potency of free or low cost trial use (in which users experience "always on" and develop an appreciation).

i. *Perceived, or real, absence of interesting content or applications that need broadband access speeds*

From our consumer survey, some insight into the relationship between high-speed demand and the provision of entertainment content in particular is gleaned from the survey question "what would need to change for you to use the Internet to view entertainment video such as a full-length movie or TV show?" There appears to be some resistance to using the Internet to view entertainment video, but this resistance declines from no access, to dial-up, to high-speed users. Excluding respondents who "would not use their PC and the Internet to view entertainment content", the most important reason is the "ability to view in convenient location (for instance, your TV in your living room)." "More awareness of how to find interesting content", and "access to a wider range of content" are less important reasons for "change" across the whole sample, but are relatively more important to high-speed users. Clearly, more research is required on this issue. Given content is currently being designed for high-speed access on a user-pay basis, future research should consider conjoint panels that focus on content attributes and prices (similar to that used in cable TV markets) rather than access attributes. Our telework research suggests that as fewer and fewer teleworkers can be classified as technophiles, attraction to applications becomes secondary to reliable provision of basic work functionality. Our secondary research shows that while proponents of broadband consistently tout a variety of interesting applications, consumer usage continues to be dominated by email and web browsing (just as with dial-up access). There are encouraging trends among broadband users towards more time on line and some more time using applications that benefit from broadband (particularly games), but there is no evidence of a "killer app" emerging nor is the search for such an application necessarily the best strategy. Instead, we would recommend an emphasis on promoting the generic benefits of broadband (especially, for example, through trial exposure) and broad support for the evolution of multiple applications that can differentiate broadband.

j. *Limitations in the actual speed of existing services (i.e., are existing services really "broadband enough"?); what upstream and downstream speeds would make a difference in subscription rates, and at what pricing?*

In our consumer survey, after reliability, speed is the next most important attribute. Consumers are WTP between $8.22 (Lower income) to $32.15 (With high-speed) to increase speed from dial-up (*slow*) to fast for downloads but relatively slower for uploads (*fast*), and from fast to very fast for uploads and downloads (*very fast*). Our teleworker survey suggests that while speed is not in itself a salient issue, it is important through its manifestation in file download times; we would expect that the ratio of typical file size to bandwidth will strongly influence teleworker sensitivity to speed. Our small business/SOHO analysis shows speed, always on, and email and instant messaging applications as all being cited as critical (and quite similar in criticality) whereas e-commerce, streaming media, integrated services, remote access, and videoconferencing were all perceived as substantially less critical. Our secondary research also suggests an interesting trend towards broadband users increasingly becoming sources of content; ultimately this could reflect itself in more sensitivity to upstream speeds. Overall, these findings suggest sensitivity to speed; it should be possible to tier the market on speed and expect some migration over time towards higher speed services, although our tools were not sufficient to distinguish particular speed/price points beyond the *slow*, *fast*, and *very fast* characterizations (we need to limit the number of choices in each attribute in order to get statistically reliable conjoint analysis across multiple attributes).

k. *Inability to access the Internet via broadband speeds at other than the primary home or office location*

In managing the scope of our consumer questionnaire, we needed to eliminate this from the questionnaire during pre-testing, so this question is not directly addressed. Regarding the relationship between home and office broadband access, our secondary research is in conflict; some authors suggest that broadband access at work may serve as a substitute for broadband access at home (for example, noting that most streaming media is actually consumed in the work place), while others suggest that broadband access at work can serve to familiarize consumers with the advantages of broadband (we have recommended in several instances above the value of trial exposure for users). We did not uncover any particular information on the relationship between broadband access in home or office and access in other locations (e.g., mobile access or access while traveling); a general observation, though, would be that the tendency of users to become adapted to broadband once they use it should make them more desirous of broadband in locations other than home or office (in other words, while it might be hard to get a current dial-up user to value mobile and remote broadband access, it should be disproportionately easier to get a home or office broadband user to value mobile and remote broadband access.)

3. *To what extent is the U.S. Government currently a subscriber of broadband services, and could increased Government use of broadband motivate higher subscription rates among residences and businesses?*

   Initial results at ascertaining Government connectivity are moderate, creating only a general view. We believe follow up surveys could shed some more light on this topic. However, based on conversations with officials within US agencies, it is not clear that the government understands the relevant concepts.

   We found a great deal of information indicating that the government is indeed looking at ways of improving efficiency and reduced costs through the use of Information and Communication Technology (ICT). However, these efforts do not focus specifically on broadband services per se. We did find the terms "broadband", "high speed" and "high rate" in numerous federal reports concerning such things as telework, work process, ecommerce and egovernment. We also found a number of reports and proposed legislation that mentioned the role of broadband as a general driver of economic growth.

   While we do believe that government should look at the role of broadband, we also believe that this is just one part of a much bigger effort; that of understanding how all of ICT can help government be more efficient and cut costs. Nonetheless, it may be worthwhile for industry to demonstrate to government why they should look more closely at the role of broadband. For example, the conclusions reached in this document could be used as a launching point for more in depth investigation by a government agency, such as GAO.

   As for Government driving broadband internally and externally, they are moving in the right direction. Instead of finding the killer app, they are slowly developing accessible, reliable and user-friendly services and applications to better serve their own and their citizen's needs. We recommend to developers focus on current ICT projects that will most likely evolve into useful bundled applications and services, rather than attempt to identify the next best thing. We also recommend that government continue to focus on telecommuting, improved online business process, and accessible portals.

4. *What are the potentials for broadband to support telecommuting/telework practices? What are the*

major indicators of broadband adoption for telecommuting/telework?

Our key findings from our telework research are:

Finding 1: "Telework" is just "work." Respondents do not distinguish telework from "normal work." They do not segment their work into "office" work and "home" work. Nor do they consider themselves unusual or experimental in terms of their work practices.

Finding 2: Teleworkers divide their work into "tasks" and "relationships." Both of these need support. *Task work* involves things an individual does alone, including writing, research, data analysis, and so forth. *Relationship work* involves those things that must be done with others, including meeting with team members and with clients, mentoring, and supervising.

Finding 3: Telework is a continuum. The traditional view that juxtaposes office work to telework is outdated. The extension of the workday beyond "office hours" means that it is more realistic to think of teleworking as a continuum ranging from workers who perform all or most of their work in the office to those that perform all or most of their work at other locations (at home, on the road, at clients' sites).

Finding 4: Teleworkers in "non-tech" companies largely are responsible for creating their work environments, including acquiring technological equipment and support. Most respondents were given no additional support in terms of equipment or technical assistance, as compared to traditional office workers. Technology companies tended to provide more resources; employees of these companies noted they were given laptops and even software to use to telecommute more efficiently (such as instant messaging).

Finding 5: Formal telecommuting policies and statements of expectations are largely nonexistent. Even when policies exist (usually in tech companies), they may not be effective in guiding action.

Finding 6: Most organizations provide little to no support for their teleworkers. Teleworkers indicated that they learned "on the job" how to telework. Organizations sometimes supplemented the experience with literature or short training seminars, but not at the outset of the job. The idea of "economic" or "organizational" support—in which the organization helps the employee by shouldering some of the burden of working away from the office—did not resonate with the respondents. They had not considered that possibility.

Finding 7: Technology is a core attribute of telework. Results confirmed our expectation that technology is an essential component of telework. Respondents consistently indicated that without the ability to access documents, databases, intranets, etc. they could not do their job.

Finding 8: Teleworkers use established technologies, but will adopt innovative technologies if they meet communication and information needs.

Finding 9: Dial-up connections dominate. With only a few exceptions, our respondents connected through traditional dial-up phone lines rather than through broadband. Several connected though toll free lines, several through an extra business line, and one through satellite (we do not know if this connection was broadband). Not all had broadband service available in their area. For those who did, the decision not to subscribe was the result of a cost-benefit analysis, with benefit having to be measured in terms of increased work productivity. While they acknowledged that slower connections meant wasted time or lower productivity, they would argue they were getting by on what was available.

Finding 10: Few respondents knew what "broadband" was. Many had no broadband service. Most referred to it or understood it as high speed internet access. "DSL" was sometimes used as a replacement. Employees of technology companies were somewhat more confident in their definitions.

Finding 11: Requirements of teleworking practices potentially can drive broadband adoption. Respondents are committed to making their arrangements work. These commitments are consistent with the opportunities afforded by broadband, either because broadband can solve current inefficiencies, or because it can meet perceived requirements.

These led to several specific recommendations:

1. Make broadband affordable to teleworkers specifically.
2. Emphasize improved productivity and efficiency, rather than increased content.
3. Further investigate technology for supporting relationships.
4. Package excellent technical support with broadband access.
5. Work with access providers or organizational consultants to develop a "turn-key" telework package.
6. Emphasize the reliability and stability of broadband access, rather than its ability to support new and innovative work practices.
7. Finally, make broadband easier to understand.

Background on Broadband

A large community of interested parties – in industry, government, and academia – is debating the current status of broadband, its direction, and appropriate policies. While in this report we offer some original primary research on drivers of broadband demand, in this section we will examine the broader context of the current broadband debate.

The Definition of Broadband

Broadband is usually thought of as related to data rate, but, in fact, there is both disagreement on what data rate might define broadband and on whether data rate is the defining characteristic at all.

The United States Federal Communications Commission (FCC) generates substantial statistical data on broadband as well as advocating policy initiatives, so its definition is particularly important. Even here, though, we find variations. The FCC originally defined *broadband* to mean greater than 200 kbps information carrying capacity in both directions[3] but then added other descriptive terms such as 'high-speed services' (at least 200 kbps in at least one direction), 'advanced services' (at least 200 kbps in both directions and thus a proper subset of high-speed services) and 'broadband services' (a larger subset of services that end users can access with asymmetric capabilities and speeds that are less than 200 Kbps, but are generally also considered high-speed, such as greater than 128 Kbps in a wireless environment or 144 Kbps in a wireline environment)[4]. But note how FCC Chairman Michael Powell addresses the definition of broadband in a late 2001 speech:

> Oddly enough a clear, uniformly accepted definition evades us. It is accepted that whatever broadband is, it is fast (the Commission has defined it as 200kbs). We have very forceful debates about how fast is fast enough. I submit, however, that broadband is not a speed. It is a medium that offers a wide potential set of applications and uses. With the telephone, we knew what the "killer app" was. It was voice. The "broad" in broadband should be recognized as meaning more than the "fat, fast pipe." It should represent the nearly infinite possible uses and applications that might be developed and that a consumer might use. I think broadband should be viewed holistically as a technical capability that can be matched to consumers' broad communication, entertainment, information, and commercial desires.

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[3] U. S. Federal Communications Commission, First Advanced Telecommunications Report, CC Docket No. 98-146, Released February 2, 1999, <http://www.fcc.gov/Bureaus/Common_Carrier/Orders/1999/fcc99005.txt>, p. 20)

[4] U. S. Federal Communications Commission, Notice of Inquiry Concerning Advanced Telecommunications Capability, CC Docket No. 98-146, Released February 18, 2000. <http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-00-57A1.pdf >, p. 2

> I start by trying to come together on what are the indispensable components of broadband functionality. It is, to my mind, (1) a digital architecture, (2) capable of carrying IP or other multi-layered protocols, (3) that has an "always on" functionality, and (4) that is capable of scaling to greater capacity and functionality as uses evolve and bandwidth hungry applications emerge.
>
> I also believe that we should conceptualize broadband capability as a function that can ride on many different electronic platforms. Broadband is not a copper wire. It is not a coaxial cable. It is not a wireless channel. It is all of these things. The capability can ride on many platforms (and should) in order to tailor solutions to consumer patterns and interests.[5]

Returning to bit rate based definitions, the OECD (a collector of statistics and commentator on international broadband policy) uses a slightly higher rate for downstream, 256 kbps, but allows as low as a 64 kbps upstream rate[6].

The Canadian National Broadband Task Force suggests that the minimal bit rate for broadband should be substantially above 200 kbps, relying on tables such as the following[7]:

Application	Minimum Bit Rate	Desirable Bit Rate
Tele-working	110 kbps	7000 kbps
Video Conferencing	110 kbps	800 kbps
Tele or E-Learning	110 kbps	7000 kbps
Tele-medicine	110 kbps	7000 kbps
Video Telephony	70 kbps	200 kbps
Near Video-on-Demand	1000 kbps	7000 kbps
Movies-on-Demand	1000 kbps	7000 kbps
Audio-on-Demand	110 kbps	700 kbps
Telegames	40 kbps	600 kbps
Home Shopping	40 kbps	7000 kbps
Electronic Banking	40 kbps	400 kbps
Electronic Newspaper	40 kbps	2000 kbps
Digital TV	1000 kbps	7000 kbps

From this they conclude that some important applications *require* a rate higher than 200 kbps and that most *benefit* from a rate higher than 200 kbps. More ambitiously, others note that High Definition Television requires yet higher bit rates (19 Mbps) and that emulation of workplace networking would require the same 10 or 100 Mbps access that workers typically enjoy through a direct Ethernet connection in the office – so claim a better definition of broadband would be 100 Mbps[8].

Chairman Powell calls out a particular technical characteristic other than bit-rate, "always on" connectivity. Another technical characteristic that is occasionally required of broadband is low latency – this is important in two-way human communication and in online interactive gaming. And others have also adopted application

[5] Powell, Michael K. "Remarks of Michael K. Powell, Chairman Federal Communications Commission at the National Summit on Broadband Deployment," Washington, D.C., October 25, 2001. <http://www.fcc.gov/Speeches/Powell/2001/spmkp110.html.>, pp. 2-3)

[6] Organization for Economic Co-operation and Development, The Development of Broadband Access in OECD Countries, October 29, 2001. <http://www.oecd.org/pdf/M00020000/M00020255.pdf>, p. 6

[7] Canadian National Broadband Task Force, The New National Dream: Networking the Nation for Broadband Access, Submitted to Canadian Minister Tobin on June 18, 2001. <http://broadband.gc.ca/Broadband-document/english/table_content.htm>, p. 32

[8] TechNet. A National Imperative: Universal Availability of Broadband by 2010. January 15 ,2002. <http://www.technet.org/news/newsreleases/2002-01-15.64.pdf>, p. 6

oriented definitions of broadband similar to Chairman Powell's[9].

Notwithstanding this profusion of definitions, we will for the most part consider broadband in the sense of the FCC's "high speed lines" (at least 200 kbps in at least one direction), the definition most consistent with calling DSL and cable modem deployments broadband. But this is not a trivial choice; not all applications will run at these rates and so not everything that we can imagine doing with broadband will be achievable under this definition.

The Current Status of Broadband

Broadband is built on top of the phenomenon of internet access, so it is worthwhile to first review basic internet usage. Most Americans use the internet: the Department of Commerce reports 143 million Americans (54% of the population) as users as of September, 2001, while the UCLA Center for Communication Policy in their 2001 survey estimates a higher percentage: 72.3%.[10] Moreover, the use has expanded from affluent and technology savvy segments to slower to adopt segments such as rural and minority populations (as measured by a decrease in the Gini coefficient of disparity used by economists).[11] And we can expect a number of the remaining non-users to start using the internet in the next twelve months, indeed, if we extrapolate from current rates of adoption by non-users and the current user base, 96% of the population would be using the internet by 2006 – a penetration comparable to that of basic telephone service.[12]

While the majority of the population already experiences the internet, a much smaller fraction has broadband access. There is variation in estimates of current broadband penetration, but two salient sources include the Department of Commerce's estimate that 20% of internet users (and hence about 11% of the population) were broadband users as of September, 2001 and the FCC's own semi-yearly statistics collection on number of high speed lines:[13]

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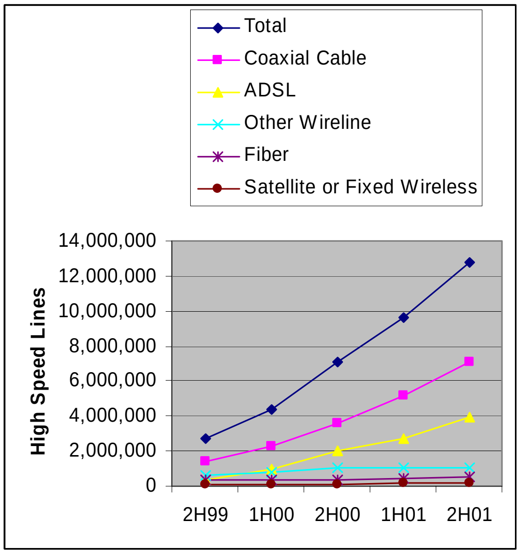
[9] See, for example, the application based definition in National Research Council, Broadband: Bringing Home the Bits. Washington, D.C.: National Academy Press, 2002, <http://books.nap.edu/books/0309082730/html/index.html>, pp. 78-80, and the commentary regarding business definition of broadband in Kneko Burney, "The Big Comeback: Excerpts from 'Business Broadband in a Changed Economy'," In-Stat MDR, May 2002, that U S business decision makers don't seem to associate broadband with a particular bit rate definition but rather as encompassing high-speed networks of many varieties and concludes that businesses no longer see a natural separation between local area and wide area networks.

[10] See United States Department of Commerce. A Nation Online: How Americans are Expanding Their Use of the Internet. February 2002. <http://www.ntia.doc.gov/opadhome/digitalnation/index.html> and The UCLA Center for Communication Policy, The UCLA Internet Report 2001: Surveying the Digital Future: Year Two, November, 2001. <http://www.ccp.ucla.edu/pdf/UCLA-Internet-Report-2001.pdf>, p. 17

[11] ibid, Department of Commerce, p. 85.

[12] Ibid, UCLA, noting that 44.4% of non-users in their 2001 survey plan to go online in the next year, up from 40% in their 2000 survey (p. 28).

[13] See U. S. Federal Communications Commission, High Speed Services for Internet Access: Status as of December 31, 2001, July 2002, < http://www.fcc.gov/Bureaus/Common_Carrier/Reports/FCC-State_Link/IAD/hspd0702.pdf>, p. 2, and its predecesors.



A somewhat larger fraction – better than 40% – of small business internet users have broadband access and an even larger fraction – 85% – of medium and larger businesses have connectivity at their main offices.[14]

Is the adoption of broadband unusually slow? In the first half of 2002, both the technology industry and various government organizations identified a problem with the rate of broadband adoption. These themes have now become much more muted. Key points regarding the "abnormality" of adoption are:

- Changes in the rate of increase of adoption.
- Availability of broadband relative to demand.
- Rate of adoption of broadband relative to other examples of adoption.

Changes in Rate of Increase of Adoption

A useful set of figures on broadband adoption comes from the FCC[15]:

First Half 2000	57% growth
Second Half 2000	62% growth
First Half 2002	36% growth
Second Half 2002	33% growth

The substantial decline in growth rates between 2002 and 2001 has been a cause for alarm.

What expectation should we have on fractional growth rates for a diffusion process? Fractional growth rates are the most commonly cited growth statistics (the change in the last period divided by the amount at the beginning of the period; usually these are stated in percentage terms as in the FCC statistics above; a constant fractional growth rate implies exponential growth). If diffusion is occurring in a finite population, saturation will ultimately occur and certainly by that point growth rates will have declined precipitously. More interestingly, though, take the simplest mathematical model for diffusion, the famous "logistic curve" or "S-shaped diffusion curve" given by

$$N(t) = \frac{N^*}{1 + \exp(-\eta - \phi t)}$$

[14] For small businesses, 38% of 250 small businesses surveyed at the beginning of May, 2002 for Women Impacting Public Policy subscribe to high speed internet access (the sample size is sufficient for an accuracy of +/- 6% at the 95% confidence level (KRC Research, Small Business Solutions: Utilizing the Internet and High Speed Access, prepared for Woman Impacting Public Policy, May, 2002). Cahners In-Stat notes that 87% of larger enterprises have broadband connectivity at their main office versus 86% for middle size companies and 56% for smaller companies (Cahners In-Stat Group, "Moving Towards Broadband Ubiquity in U.S. Business Markets," Report No: BB0101UB, April, 2001, <http://www.instat.com/catalog/downloads/whitepaper_bb ubiquity.asp >, p. 14).

[15] See note 11.

where $N(t)$ is the number of adopters at time t, N^* is the ultimate number of adopters at saturation, η locates the curve in time and ϕ gives the rate of adoption.[16] The fractional growth rate for this curve is given by

$$\frac{1}{N(t)}\frac{dN(t)}{dt} = \frac{\phi \exp(-\eta - \phi t)}{1 + \exp(-\eta - \phi t)},$$

a function that declines continuously: note the limits:

$$\lim_{t \to -\infty} \frac{1}{N(t)}\frac{dN(t)}{dt} = \phi$$

and

$$\lim_{t \to \infty} \frac{1}{N(t)}\frac{dN(t)}{dt} = 0$$

In other words, a diffusion process following the classic S-shaped curve exhibits continuously declining fractional growth rates. (A more intuitive statement might be that an S-shaped curve appears to exhibit classic exponential growth at its very beginning with fractional growth rate ϕ, but is in fact continually falling in growth rate as it moves on towards zero fractional growth rate at saturation.) This doesn't tell us, for example, whether the amount of decrease in growth rates observed should have been expected (in fact the decline in growth rates is substantially higher than is experienced by the best fit logistic curve), but it does suggest that the fact of declining growth rates alone is not sufficient to suggest an abnormal diffusion process.

In the second half of 2002, the whole issue of declining growth rates has become muted. For example, promotion for a recent (and frequently cited) marketing study includes the quote[17]:

> *"But I don't know why commentators constantly complain about the lack of broadband adoption in the US. The residential sector grew over 80% between 2000 and 2001," says Mr. Macklin [an eMarketer analyst]. "I'd characterize that as significant."*

An October, 2002 Wall Street Journal article on Comcast's cable modem business states[18]:

> *After a disappointingly slow start that staggered an expectant Internet industry salivating to serve customers with high-speed connections, broadband usage has been accelerating to the point where it is reaching critical mass.*

The FCC has opined that the rate of adoption of advances services is satisfactory[19] and the Office of Technology Policy in the Department of Commerce describes demand in its September report as "robust" (see quote in following section).

Availability of Broadband Relative to Demand

A second point of concern emphasized in the first half of 2002 is the discrepancy between availability of broadband (cited as being available to almost all the population) and

[16] Stoneman, Paul. The Economics of Technological Diffusion. Oxford, UK: Blackwell Publishers, 2002, p.12

[17] eMarketer, "Broadband Demand and Dial-Up Access," August 2002, <http://www.emarketer.com/products/report.php?2000121&PHPSESSID=8c7dcd92dac8aa833d2f36a46b2a6724>

[18] ibid, Wall Street Journal.

[19] FCC, "Third Report on the Availability of High Speed and Advanced Telecommunications Capacity," February 7, 2002.

actual subscription rates (in the 10% range). Evidence of widespread availability undermined explanations that there are few adopters simply because broadband is not available, and turned the focus to understanding whether demand drivers are abnormally low (the subject of much of this report).

However, the sense that low demand relative to availability is a cause for concern has also declined throughout 2002. Compare, for example, the following quote (from a speech by Bruce Mehlman, Assistant Secretary for Technology Policy, U S Department of Commerce, in March of 2002)[20]:

> *THE CHALLENGE for those of us who see broadband as critical to U.S. competitiveness is that, despite availability to a majority of American homes, and notwithstanding fast subscribership growth, only a fraction of American consumers have chosen to subscribe so far - just 10% by some estimates, although a few leading markets have seen up to 30% take rates.*

with the following quote from the report "Understanding Broadband Demand" issued by Assistant Secretary Mehlman's office in September of 2002[21]:

> *We have found that demand for broadband is robust, although as with most new technologies, broadband supply currently exceeds demand (in all but the most rural markets).*

The first quote suggests that the discrepancy between supply and demand is a cause for concern while the second suggests it is to be expected. (Indeed, there are many historic diffusion processes in which simple availability of an innovation has not been the limiting factor in adoption rate.)

Throughout 2002, there has been a tendency to imply that low subscription rates relative to availability indicate that only demand side issues are salient. Simply put, widespread availability of broadband is not the same as widespread availability at prices that stimulate demand, so that it is incorrect to assume that low subscription rates relative to availability imply there are no supply side issues or opportunities.

Rate of adoption of broadband relative to other examples of adoption

More and more commentators (particularly in the U S government administration) are comparing the rate of adoption of broadband relative to other consumer oriented technological innovations. The FCC was early in emphasizing this point; the following figure is typical and is drawn from data collected by FCC staff[22].

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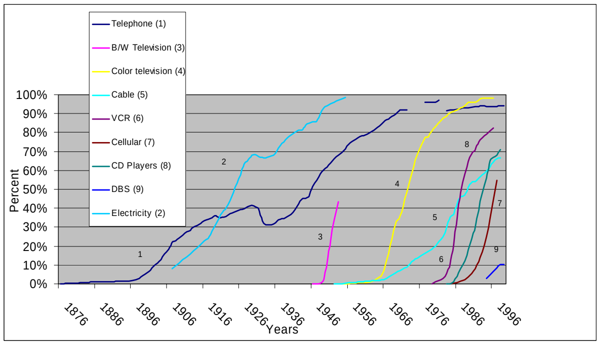
20 Mehlman, Bruce. BROADBAND: The Sky's The Limit and It's Not Falling (Yet). Before the Nortel Public Polcymakers Luncheon. 4 March 2002. <http://www.ta.doc.gov/Speeches/BPM_020304_Sky+Limit.htm>).

21 Office of Technology Policy, U.S. Department of Commerce, "Understanding Broadband Demand: A Review of Critical Issues," September 23, 2002.

22 Greg Guice, FCC, private communication, September 10, 2002.



The observation that the penetration of broadband is "faster than that of any other consumer technology" is now a standard part of FCC discussions of the matter.[23] The obvious implication of these statements is that there is nothing "abnormal" about broadband adoption rates; if anything, things are going rather well and it is therefore unclear how much intervention is required to fix a problem.

These analogies do suffer from weaknesses. Senator Lieberman's staff point out several[24]:

- It seems very liberal to compare adoption processes as diverse as the original adoption of telephony, the adoption of cellular telephony, and so on, with broadband; surely there could be many factors that distinguish the circumstances of adoption and would preclude us from concluding by comparison whether broadband adoption is fast or slow.

- But if one is going to use such comparisons, we should note that the rate of adoption for technologies has apparently been accelerating over time (at least in most cases); wouldn't this suggest that a normal adoption for broadband should be quite fast by historical standards? Further, since broadband is enhancing an activity which has already largely been adopted (internet access), one would expect faster penetration than would apply in completely new applications such as the telephone or VCR.

In addition, broadband penetration is still low; somewhere between 10% and 15% of the population, so that it is hard to meaningfully compare the elapsed time so far in broadband with the entire adoption curves of other innovations.

In summary, growth in broadband use continues. Growth clearly slowed in 2001, and although the fact of slowing growth is not in itself evidence of abnormality, the amount of decline was surprising. Nonetheless, the tone of the debate has moved from being alarmed over declining growth rates towards calling growth in broadband "robust" and comparing it favorably to previous innovations.

Is the Rate of Broadband Adoption Optimal?

If broadband has some attractive characteristics, then "problems" with the adoption process might be sufficient alone to motivate aggressive intervention by stakeholders. However, if the adoption process is thought to be normal (apparently an increasingly common perception as discussed above), then more scrutiny falls on the potential benefits of adoption and whether they are sufficient to motivate attempts to drive the process "faster than normal."

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23 Ibid, Office of Technology Policy.

24 Office of Senator Joseph I. Lieberman, "Broadband: A 21st Century Technology and Productivity Strategy," May 28, 2002.

Purported benefits of broadband generally consist of:

- National economic benefit and international competitiveness
- Specific applications
- Industry-specific benefits

National economic benefit and international competitiveness

Economic benefit arguments revolve around identifying applications enabled or enhanced by broadband and estimating their impact on economic growth. The most frequently cited study (by Crandall and Jackson[25]) uses estimates of consumer price elasticity for broadband to determine economic surplus benefit to consumers and to producers, and then cross check this by attempting to estimate the specific economic benefit of enabling particular classes of applications. The authors then calculate the net present value of accelerating broadband benefits from a leisurely 25 year adoption of broadband to a duration more on the order of 5-10 years, finally arriving at a net present value of $420 billion of consumer benefit and $80 billion of producer benefit from acceleration. In helping to explain this, they note the importance of network externalities:

> A skeptic, on reading this, will necessarily have doubts – how could speeding up the adoption of a technology have such massive benefits? The key lies in the substantial benefits that ubiquitous broadband can convey to consumers. Once virtually everyone has the service, the network effects from developing new services become very large. Moving these benefits forward a few years can create very large benefits – even when evaluated from today's perspective.

An alternative approach is taken by Pociask; he focuses on jobs created directly and indirectly by investment in broadband infrastructure: he estimates 166,000 jobs created in broadband service providers, 71,700 jobs created in equipment providers, and 974,000 indirect jobs created elsewhere in the economy using the notion of a "multiplier" between direct jobs created and indirect jobs created.[26]

Most references to economic studies on the benefit of broadband are to these two reports; there do not appear to have been substantive additional attempts to quantify numerically the economic benefit of broadband adoption.

International competitiveness is a theme in many countries' discussions of broadband. In the United States, the observation is often made that in spite of its leadership in developing the internet and broadband technology, the U S is not the fastest adopter of broadband and other countries who currently have higher penetration or may achieve higher penetration in the future may acquire substantial and persistent economic advantages.

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[25] Crandall, Robert W. and Charles L. Jackson. The $500 Billion Opportunity: The Potential Economic Benefit of Widespread Diffusion of Broadband Internet Access. July 2001, Criterion Economics, LLC. <http://www.criterioneconomics.com/documents/Crandall_Jackson_500_Billion_Opportunity_July_2001.pdf>, p. 54

[26] Pociask, Stephen. Building a Nationwide Broadband Network: Speeding Job Growth. TeleNomic Research, LLC, Herndon, VA. February 25, 2002. <http://www.newmillenniumresearch.org/event-02-25-2002/jobspaper.pdf>

Specific applications

Another common approach by proponents of broadband is to list a set of appealing applications and suggest that increased access to these applications should motivate efforts to accelerate broadband deployment.

Application Taxonomy

Typical emphasized broadband applications are:

- Entertainment Video and Audio
- Games
- Education
- National Security and Digital Government
- Teleworking
- Telehealth

as well as other miscellaneous applications. We review each here.

Entertainment Video and Audio

Since streaming audio and video at better than novelty quality are simply not feasible over narrowband, it is not surprising that broadband users are much more prolific in their consumption of streaming media (for example in a September 2001 study by McKinsey, 57% of broadband users compared to 33% of narrowband users streamed audio and 37% of broadband versus 11% of narrowband users had streamed video at least once in the prior month[27]). But after experimenting, many broadband users do not become habitual consumers of streaming audio and video.[28] Video is worse than audio: although audio quality over broadband is comparable with other high quality audio sources available to consumers, current typical broadband rates of ADSL and cable modems and the ability of PC's to process video without interfering with other tasks are impediments to the consumption of streaming video.[29] Other issues with widespread adoption of consumer streaming media include:

- the fact that the typical decoding device (a PC) is often not located where consumers want to enjoy streamed content (necessitating adoption of appropriate home networking and distributed devices by consumers)

- well publicized issues over copyright, fair use, piracy, and availability of highly desirable ("Hollywood") content to users, requiring political, legal, commercial, and technical issues to be addressed.

Downloaded audio (as opposed to streaming audio) continues to be a very popular in spite of the suspension of access via Napster – access has moved to other peer-to-peer applications and most downloaders report

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[27] McKinsey & Co., The Broadband Opportunity, September 2001, p. 10.

[28] According to a 2001 study by Arbitron and Coleman "Online media are not yet generating habitual use. The challenge of converting streaming audio trial into habitual use is not unique. It is also true for other Internet media, as 37% of [broadband users] have ever used downloaded audio, 24% have ever watched streaming video, and 46% have ever used downloaded video. The "used in last week" levels for each of these media are 12%, 5% and 3%, respectively." (Rose, Bill and Warren Kurtzman, Broadband Revolution 2 – The Media World of Speedies. Arbitron Webcast Services and Coleman Insights. <http://www.arbitron.com/downloads/broadband_2.pdf>, p. 18)

[29] ibid, p. 28.

increasing download activity – and downloaded video has been increasing in popularity. Broadband should be attractive to heavy downloaders since it reduces the download time substantially, but this trend will likely be strongly affected by the outcome of commercial and legal struggles that could substantially reduce downloading as a motivator for broadband usage, especially in the near term.

Although streaming media entertainment content is frequently touted as the necessary ingredient for increased adoption of broadband, it is not clear how quickly the problems above can be resolved nor whether it can be as strong a driver for broadband demand if content owners are able to charge profit maximizing prices. On the other hand, it appears there will likely be continued experimentation with streaming media content and business models, particularly as broadband penetration increases (and hence so does the market for content uniquely created or packaged for broadband). A salient example in this direction is Real Networks subscription service targeting broadband users with an assortment of games, music, sports, and news clips; the service had signed up nearly a million users by September, 2002 at $9.95 each.[30]

Games

Games are a success story for broadband usage: online time spent on entertainment grows from 14% of total time for narrowband to 32% for broadband, with 59% of broadband entertainment in the form of games.[31] Broadband enables more convenient download of games and, importantly, low latency connections that allow networked game play of so called "twitch games." Current generation of game consoles are intended to permit connection to broadband, allowing networked games to be played on home video game consoles in addition to PC's.[32]

Education

Increasing the availability and effectiveness of education is an attractive societal and governmental policy goal. A key and unresolved challenge, though, will be whether sources of educational content and business models can be found which produce effective education at a price that broadband consumers are willing to pay (a similar problem to finding a successful business model for providing entertainment content other than the "for free" Napster model). Currently, willingness to pay for online education is substantially below what traditional creators of such content expect to charge based on their normal distribution channels.[33] Moreover, traditional avenues for education (particularly colleges) have other value to students than efficiency of education; the "brand name" of the institution may also be quite valuable. Current college

[30] Peter Grant, "Comcast Posts Strong Growth In Cable-Modem Subscribers," *The Wall Street Journal*, October 29, 2002.

[31] McKinsey & Company, ibid, p. 45.

[32] "Console Wars," The Economist, June 20, 2002.

[33] Sage Research reports that 14.3% of consumers expressed a willingness to pay for continuing school education online but "…the most common amount of money consumers are willing to pay per college credit is $50 – far less than what they would be charged by online universities today. So how will universities develop sustainable business models? Most likely they will need sheer numbers of students in order to achieve profitability" (Sage Research, Customers at the gate: Mounting Demand for Broadband-enabled Services, February 2002.)

students, while avaricious broadband users, do not seem attracted to a cyberspace only education.[34]

National Security and Digital Government

The national security motivation for broadband relies on the implication that a broadly deployed broadband network would increase bandwidth available to communicate between government agencies and with the public in times of crisis and could lead to a more robust network infrastructure overall (itself less vulnerable to attack due to the diversity of high bandwidth connections between information sources and sinks), as well as implicitly supporting training of security oriented employees and communication between security functions.[35]

A democratic society that benefits from a high flow of information between the government and the citizenry can exploit broadband both to improve the flow of information to the public (already a success story) and to involve the public in government (where less progress has been made).[36]

These applications, as a rule, are not uniquely enabled by broadband versus narrowband, but broadband is helpful to the extent it increases individuals' use of the internet (and hence their likelihood and effectiveness in dealing with political and government issues) and also its facilitation of any corresponding multimedia content.

[34] Pew Internet and American Life Project, *The Internet Goes to College*, September 15, 2002
[35] ibid, Mehlman, Bruce.
[36] UCLA Center for Communication Policy, ibid, p. 18.

Teleworking

Teleworking is often advocated as a way to improve quality of life for employees (although there is some debate over whether the advantage to the employee of flexibility offsets the intrusion of work into location and times previously reserved for other activities) and as a way to reduce traffic congestion and time wasted in commuting to workplaces. The simplest way that broadband can support teleworking is by making the worker's network performance independent of whether they are located at home or at an office. However, this requires a bandwidth substantially higher than typical current broadband connections as the actual performance typically lies between a narrowband connection (56 kbps) and what a user might experience at work (10,000 kbps). A second and critical distinction relative to narrowband is the "always on" character of a broadband connection, which promotes the kind of multi-tasking between online activities, phone, and other tasks that a worker would be used to in an office environment. Indeed, a substantial fraction of broadband users do telecommute at least part of the time, broadband seems to have been helpful in their integrating work, home, and community life, and they tend to see broadband as beneficial to their work.[37] Elsewhere in this report we describe new primary research in understanding how teleworkers relate to broadband technology.

Telehealth

The role of broadband in health care revolves around two main applications:

[37] Ibid, Pew Internet Life Project, pp. 18-19.

- facilitating remote diagnosis and treatment and collaboration between physically separated health specialists

- high quality in-home monitoring of and interaction with patients.

Consumers themselves are unlikely to drive investments in telehealth and, with increasing cost pressure within the health provider industry, we should expect the success of broadband applications of telehealth to depend primarily on whether they reduce operating costs of hospitals and clinics.

Miscellaneous

Ecommerce is an important application in both narrowband and broadband, but broadband users are more active shoppers and tend to be happier with online shopping.[38]

Internet telephony to date has largely emerged in three applications: in the core of newer long distance networks (largely invisible to voice customers of these networks), as a desktop telephone solution in new buildings in which a single local area network serves both telephones and computers, and as a PC application in which low voice quality is offset by the opportunity to avoid high international tolls. Telephony could be more universally integrated into broadband links, but the pace of this will be limited both by the fact that a functioning installed network already satisfies most telephony requirements (which are only slowly growing), by the business interests of current telephony providers, and by the pace of evolution of the regulatory framework for voice services.

An extension of telephony that would strongly benefit from broadband is video telephony – of interest since first demonstrated in the 1960's. However, substantial uncertainty remains about how and when this will emerge as an important application and the extent to which broadband will enable it.[39]

E-appliances can be thought of as internet enabling many more devices to be attached to the internet – for example refrigerators, lights, security systems, etc. To the extent such networked devices need to communicate beyond the local environment, the "always on" characteristic of a broadband connection will be very helpful. Higher bit rates will usually be much less important since much of the information exchanged between such appliances will not require large bit rates (with the potentially important exception of streaming media such as a monitoring camera within a security system being viewed from a remote location).

Even a potentially compelling application can end up having little actual effect on broadband demand if it is not available over the "flavor" of broadband that most subscribers purchase. One reason is differences in bandwidth already discussed, but another is active choices by service providers to restrict access to certain

[38] Ibid, McKinsey & Company, p. 10.

[39] See Kraut, Robert E. and Robert S. Fish, "Prospects for Videotelephony," in Finn, Kathleen et al., eds., Video-Mediated Communication, Mahwah, NJ: Lawrence Erlbaum Assoc., 1997, for a balanced discussion of the potential for videophones.

applications.[40] This may be for reasons of meeting traffic engineering expectations (and the related economic expectations) when resources are shared – a cable based operator may be sharing bandwidth among multiple subscribers – or may related to a desire by the service provider to control revenue generation associated with a particular application. An example of the latter would be cable companies' restrictions on the delivery of streaming video via cable modems; we might anticipate similar concerns by phone companies regarding offering of multiple additional phone lines by an ISP over a DSL connection.

Beyond the Killer Application

Part of the angst over broadband deployment rests on the lack of an identified killer application, and indeed part of the justification for creating taxonomies of potential applications of broadband is the search for such an application. A *killer application* is one so compelling and so dependent on a particular infrastructure that the application by itself can motivate the necessary infrastructure investment. But killer applications are easier to determine in hindsight than to predict. To the extent a killer application exhibits substantial network externalities this will be even more true – the adoption rate can be expected to be quite low for some period (during which time the role as a killer application will not be validated by evidence) until a critical mass is reached, at which point adoption proceeds much more rapidly than a similar application without network externalities.

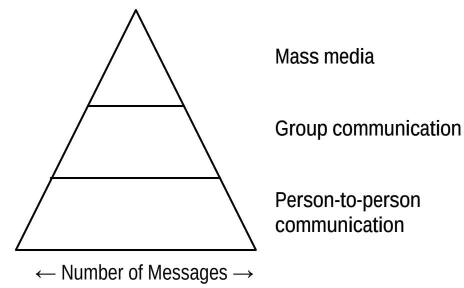
[40] Jonathan Kim, "Cable Firms Faulted for Restrictions on Internet Service," Washington Post, June 28, 2002, Page E03.

Although it simplifies (and may accelerate) adoption dynamics for broadband to have a single clear killer application, it may not be necessary. The current dominant driver for broadband adoption is simply accessing the web and performing mostly current applications more quickly and with the convenience of "always on."[41] And user satisfaction with broadband after adopting it for these reasons is quite high.[42] A pragmatic approach to the question of a killer application might be to support broad innovation in applications and rely on "natural selection" to find applications that ultimately end up playing a substantial role in infrastructure investments, in the meantime relying on "better web access" as a motivator.

Indeed, it is not clear that the most important applications will be in the area of high value "content," an assumption frequently made and captured in the phrase "content is king." While it is true that most users view the internet primarily as a source of content and information – the most popular metaphor for the internet is "library"[43] – the highest popularity application is actually a communication application – email – for both narrowband and broadband users.[44] Communication applications tend to exhibit high network externalities and could end up driving most broadband bit traffic.[45] Examples include various types of messaging, a shift to carrying voice traffic on broadband

[41] Ibid, Pew Internet Life Project, pp. 2-3.
[42] Arbitron and Coleman note that 86% of home broadband users were "extremely" or "very satisfied" in 2001, remaining consistent with 85% in 2000 (ibid, Arbitron & Coleman, p. 8).
[43] Ibid, Pew Internet Life Project, p. 17.
[44] Ibid, Department of Commerce, p. 31 and UCLA, p. 17.
[45] Odlyzko, Andrew. "Content is not King," January 3, 2001, <http://www.dtc.umn.edu/~odlyzko/doc/history.communications2.pdf>

connections, and the sourcing by individuals of content such as pictures and video (the manifestation of individuals' interest in "publishing" on line can already be seen in the rising popularity of online diaries known as web logs or "blogs" and indeed, broadband users are already showing a greater propensity to create and manage their own content than do narrowband users).[46] Rather than viewing a dichotomy between content and communication, another perspective would be to consider content as a pyramid with a low volume of content that is valuable to a very large population at the top ("Hollywood" content and mass media) and with a potentially very large amount of content that is valuable to a few at the bottom (person-to-person communication). In between lay various intermediate combinations, such as specialized training material, local government information, and multi-person collaborative work. The societal impact of each layer of content in the pyramid is the product of the amount of content times the average number of individuals for whom each instance of content is valuable. It is not clear whether this product will be higher at the top of the pyramid, at the bottom of the pyramid, in between, or indeed whether it is necessarily true that any particular layer of the pyramid will dominate the others. Again, a pragmatic approach would be to encourage the formation of content at all layers of the pyramid, and in particular content that is enhanced or enabled by broadband connectivity (content that includes large file sizes, various types of streaming media, or relies on always on connectivity).



A particular implication of content creation by a large number of users is the question of symmetry versus asymmetry in broadband. To the extent users create substantial amounts of content and embrace streaming, email, and peer-to-peer distributed storage networking to share content, the need for symmetric high speed access will increase. This can be an issue both with particular choices of technology (e.g., the asymmetry implicit in ADSL) and the network traffic engineering and business models of service providers.

Industry-specific benefits

The technology and telecommunications industry have seen precipitous reversals of fortune since peaking at the turn of the century. A more rapid rate of adoption of broadband would benefit many participants in these industries. To the extent aggressive developments in these industries are thought to have played a substantial role in productivity gains for the economy as a whole in the 90's, a case can be made for minimizing disruption during the current downturn so that continued productivity gains will be achievable via technology and communications industries in the future.

[46] ibid, Pew Internet Life Project, p. 3.

So, Then, What Really Mediates Broadband Adoption Rates

From the preceding discussion, there seem to be a number of potential drivers for broadband demand. Here, we summarize and comment on the salient drivers.

Availability

This is largely assumed to have receded as an issue except in rural and economically disadvantaged populations (fostering an extension to the "digital divide" discussion). Nonetheless, availability plays a role in supply side dynamics, particularly competition, though we will not discuss this further here.

Price

Price is critical, though complicated by intense interactions between essentially all supply and demand side issues in setting price and price elasticity. An example is consideration of whether an aggressive effort by technology suppliers to reduce the cost of broadband infrastructure would increase the rate of adoption; if service providers set prices to maximize profitability in a monopolistic or oligopolistic framework, cost reduction will be reflected as increased supplier profit levels rather than decreased service prices and increased rate of adoption.

Applications and Content

Explanations of applications' and content's roles in driving adoption are very diverse, leading to a possibility of substantial divergence in proposals to affect demand through application and content creation. Positions include:

- Hollywood content is the key; efforts to reduce content owner reluctance to make such content available are critical. Or the opposite position – Hollywood content will only be marginally significant and the key driver for adoption will be communication between individuals (person-person, person-machine, machine-machine).
- Content is not a key driver; adopters of broadband value the improved experience of broadband by itself as evidenced by very low churn rates among broadband subscribers.
- There is a smorgasbord of promising applications, and with so many important possibilities, a killer application will surely emerge. A slightly different approach is to state that, whether they are economically potent enough to drive broadband adoption or not, there are many applications of broadband that society would and should value.

Many observers point out the critical role of externalities in adoption. In communication based technologies in particular we typically see two different types of externalities playing a role: network externalities, in which the value to a particular adopter increases as others adopt based on the connections created, and complementary product externalities, in which the value of adoption increases as complementary products are introduced (and conversely, the value of the complementary products increases as adoption of the original service or product increases). Indeed, such externalities can be sufficient as an explanation of why adoption takes a substantial time after availability (that is, externalities can form an alternative simple explanation to that of price and price-elasticity). A characteristic of adoption curves in the presence of externalities is slow initial adoption followed by very rapid adoption after "critical mass" is reached. Externalities also suggest policies of "priming the pump" to decrease the time to critical mass.

The Overall Sense of the Discourse

The discourse on broadband appears to have cooled since early in 2002 as many participants start to describe the broadband adoption process as proceeding at a reasonable pace. This is by no means universal, and those parties most strongly affected continue to express substantial concern (for example, the technology industry). Regardless, the belief that rapid adoption is beneficial is broadly held. The result is a general sense of the value of pursuing some initiatives designed to spur adoption but without the level of support and priority of a national initiative akin to putting a man on the moon.

Estimating Consumer Preferences for Internet Access Service

Abstract. Data obtained from a nationwide mail survey during September and October 2002 are used to construct a profile of residential Internet access, and estimate consumer preferences for bundled attributes, "always on" connection, cost, speed, installation and reliability. Preliminary analysis suggests about 19 percent of the population have a high-speed connection, and the mean price paid per month for dial-up and high-speed access is $17.51 and $40.76, respectively. Econometric estimates show that consumers are willing to pay $13.25 to $39.12 for more reliable service, $8.22 to $32.15 for faster service, and $0.91 to $17.29 for always on connectivity. High-speed users value all attributes higher than other users, while higher income users value attributes more highly than lower income users.

November 12, 2002

I. Introduction

Information technology (IT) and advanced communications are playing an increasing role in national productivity growth, the creation of new network-based activities, and improving education and living standards.[47] From 1997 to 2001 the percentage of the US population that use computers increased from 53.5 percent to 65.6 percent, and Internet use increased from 22.2 percent to 53.9 percent (NTIA 2000 & 2002, Bureau of Labor Statistics (BLS) 2001). The importance of access to advanced communications for continuing socioeconomic progress is reflected in recent remarks by President Bush (2002) who states that the US "must be aggressive about the expansion of broadband technology." Accordingly, both industry and government are debating possible initiatives that would increase the deployment of broadband infrastructure. Many of the proposals discuss the technological virtues of the infrastructure, and concentrate on measures to stimulate the supply of broadband. These proposals include universal service provision, providing tax incentives to service providers to build out broadband networks, and liberalization of telecommunications markets.[48]

On the demand-side, broadband subscription rates during the "early adopter" period from 1998 to 2001 have outpaced color television, cellular telephone, pagers and VCRs (NTIA 2002). Recent estimates from the BLS (2001) and Grant (2002) indicate about 13 percent of households subscribe to broadband Internet, and J.P. Morgan (2001) forecast strong growth in residential broadband subscribers to 48 percent of households in 2005. However, while these estimates provide some optimism to a telecom industry slowed by the economic downturn and financial uncertainty, they provide very little specific information about consumer behavior toward broadband Internet subscription. Besides econometric studies of Internet access choice by Goolsbee (2000) and Varian (2002), which consider the trade-off between access speed and subscription

[47] *See* National Telecommunications and Information Administration (NTIA; 2000), Bakos (2001), Borenstein and Saloner (2001), Jorgenson (2001), Litan and Rivlin (2001), and Röller and Waverman (2001).
[48] Federal Communications Commission (FCC; 2001 & 2002) data indicate that about 70 percent of US households have access to cable modem service, and 45 percent have access to DSL at 2001.

price, there is limited research examining the service attributes preferred by consumers, their demographics, and their willingness to pay (WTP).

This study uses stated preference (SP) data, obtained from a nationwide mail survey of 386 residences during September and October 2002, to examine US residential demand for Internet access. Survey data are used to construct a profile of representative Internet access and use, and estimate consumer preferences for bundled Internet access attributes, "always on" connection, cost, speed, installation and reliability. By estimating the trade-offs consumers face in their decision, analysis of survey data provides information for the design, pricing and marketing of more effective Internet access services. Empirical results may also prove useful for policy makers debating the "digital divide" and policies that promote access to the Internet, e-commerce and educational opportunities.[49] Section II reviews previous studies of residential Internet demand, and a theory of demand is proposed in Section III. Section IV discusses data collection and econometric methods. A profile of residential Internet access and use is presented in Section V. Section VI estimates consumer preferences for alternative types of Internet access, and Section VII presents conclusions.

II. Previous Studies of Internet Demand

From 1990 to 1999 additional residential telephone lines from US households increased from 3.9 to 23.7 million (FCC 2002). The purchase of a second telephone line allowed many dial-up Internet users to simulate one aspect of the always on feature of broadband by using the Internet and placing telephone calls at the same time. Since such users are likely early adopters of broadband, studies of the demand for telephone lines dedicated to Internet access provide a useful starting point for analyzing the demand for broadband.

A. Additional Lines Dedicated to Internet Access

Cassel (1999) uses survey data for about 30,000 respondents in 1997 to ascertain the characteristics of individuals with additional lines. She finds additional line ownership is positively associated with household size and income, households with teenagers, and access to the Internet with a PC and dial-up telephone modem. Cassal explores whether respondents with additional lines would be interested in 56 kbps Internet access for the monthly price of $10 to $30, or high-speed use access for $30 to $75. Interest is low across all consumer types, perhaps due to the higher cost. Results suggest that users require more speed and other attributes (such as always on functionality) before they are willing to pay up to $70 per month.

When examining data for 11,458 households, Duffy-Deno (2001) finds about 22 percent of the sample have two or more telephone lines, and the most frequently cited reason is for use with a PC and modem. By combining survey data with FCC (1998) prices, Duffy-Deno estimates a logit model of residential demand for additional access lines in the US. The

[49] "Digital divide" refers to the perceived gap in computer and Internet use between high and low income households, educated and less educated populations, white and minority populations, and urban and rural areas (NTIA 2000, Compaine 2001).

average household price elasticity of demand is -0.59, which is reasonably elastic compared to received estimates for primary telephone line demand. He concludes that moderately high sensitivity to the price of additional lines has implications for the digital divide debate. Since second line prices often exceed primary line prices because of different Federal charges, such charges may unintentionally dissuade households from obtaining "broadband like" access via a second line.

Eisner and Waldon (2001) argue that latent residential demand for broadband is reflected in the simultaneous growth of additional telephone lines and online service subscriptions. The decision to subscribe to a second line and an online service is modeled using bivariate probit and survey data for 7,539 households in 1995. Model estimates show a positive correlation between the probability's of subscribing to a second line and an online service, respectively. They conclude that the strong tie between the decision to purchase an additional line and subscribe to an online service is evidence of increasing consumer demand for broadband.

B. Broadband Internet Access

Addition of transport lines from the home partly simulate the always on attribute of broadband but provide no increase in speed. As more high-speed access services and bandwidth-intensive applications are introduced consumers are less likely to accept narrowband communications, and have greater reason to purchase a single broadband line from the home. Accordingly, more recent analyses of Internet demand consider the different speeds provided by dial-up, cable-modem, and DSL, and how budget and time constraints, and demographics affect household's choice of access.

Goolsbee (2000) examines demand for broadband Internet access using SP data from a 1999 survey of about 100,000 consumers. A probit model is estimated relating the probability of choosing cable modem Internet access to price and demographics such as years online, age, income, and education. After controlling for individual demographics, model results show an increase in the likelihood of cable modem access for people with lower prices. The elasticity of demand for cable Internet with respect to price ranges from -2.8 to -3.5.

Hausman *et al* (2001) argue a small cross-price elasticity of demand between broadband and dial-up is evidence that dial-up does not constrain broadband prices. They test this hypothesis by estimating a reduced-form demand-supply model that relates the price of broadband to dial-up price, presence of RoadRunner service, and demand and cost variables. Model results can not reject the hypothesis that dial-up prices do not constrain broadband prices, and Hausman *et al* conclude that broadband Internet is a separate relevant market for competitive analysis. However, the finding of zero cross-price elasticity should be qualified to some extent as they do not control for variation in quality-adjusted prices of Internet access. A more precise measure of cross-price elasticity requires explicit consideration of how household's trade off prices and other attributes when choosing their Internet access.

Using a sample of 5,255 households in 2000, Rappoport *et al* (2002) estimate a nested logit model where the first branch considers the choice between dial-up and broadband, and the second branch considers the choice between cable and DSL (given broadband). Model estimates provide own price elasticity's for cable and DSL of –0.587 and –1.462, respectively, and also suggest that dial-up access is not a substitute for broadband users. However, cross-price elasticity's of 0.618 and 0.766, respectively, indicate that cable and DSL are strong substitutes for one another.

Varian (2002) uses data from the "Internet Demand Experiment" project to estimate how much people are willing to pay for different levels of Internet speed. During 1998 and 1999, 70 users at UC Berkeley were able to choose various bandwidths from 8 to 128 kbps through a degraded ISDN line. Varian estimates reduced-form demand for bandwidth with own-price elasticities ranging from -1.3 to -3.1. Cross-price elasticities are generally positive and indicate that one-step lower bandwidths are perceived as substitutes for chosen bandwidth. A regression of time costs on demographics shows that users in technical and administrative jobs place significantly higher value on their time, and people are not willing to pay very much for bandwidth. Unless new applications and content are forthcoming, or broadband prices fall, Varian suggests there may not be a large surge in broadband demand in the near future.

C. Summary

Choice model estimates indicate the demand for dial-up access is sensitive to both dial-up and broadband prices, but early broadband adopter's demand is sensitive to broadband prices only. Generalization of these findings to the wider population is somewhat problematic given that "late adopters" are likely to emphasize other attributes than price and speed. Future studies must consider not only the opportunity cost of online activity, but how variation in attributes such as always on connectivity, service reliability, and ease of installation, affect the household's choice of access. Finally, a household's ability to combine different attributes with time online to save time and income from Internet activity also warrants attention.

III. Theory

Theory and received evidence suggest households use the Internet for enjoyment, to save money, and to save time. Accordingly, the labor-leisure utility maximization model is extended by assuming households desire income (y), leisure hours (l), and online activity.

A. *Model of Internet access choice*

Online activity is a function of the type of Internet access i = 1, 2, … , n, and hours online (t). Money is saved from online activity according to the function F(a, x, t), where a is household ability when using the Internet, x = [f, s, r] is a vector of access attributes, f is (always on) functionality, s is speed, and r is reliability of service. Similarly, time is saved according to G(a, x, t).[50] The general-form optimization problem is:

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[50] Installation costs can be amortized over the life of the service plan and included in p_i.

$$\max_{y,l,i,t} U(y, l, i, t) \qquad (1)$$

subject to

$y = y^o + wh - p_i + F(a, x, t)$

$h = T - l - t + G(a, x, t)$

where y^o is non-wage income, w is the hourly wage, h is hours worked, p_i is the flat-rate price of Internet access i, and T is total number of hours available. (1) shows that online activity saves money (or generates income), but costs p_i and uses t. Similarly, online activity saves time, but uses t.

Insight into how prices, household ability, and Internet functionality and speed affect the household's choice of Internet access is gained from a closed-form solution to (1). A tractable solution is obtained by conditioning the household's choice of y, l, and t upon Internet access i. Given Internet access i, and assuming CES utility, $F_i = a^{\alpha_1} x_i^{\alpha_2} t$ and $G_i = a^{\delta_1} x_i^{\delta_2} t$, the household optimization problem is:

$$\max_{y,l,t} U_i = (\phi_1 y^\rho + \phi_2 l^\rho + \phi_3 t^\rho)^{1/\rho} \qquad (2)$$

subject to

$$y_i = y^o + w(T - l_i - t_i + a^{\delta_1} x_i^{\delta_2} t_i) - p_i + a^{\alpha_1} x_i^{\alpha_2} t_i$$

Assuming second-order conditions are met, demand functions are obtained by combining any two first-order conditions to eliminate U and λ, and substituting into the budget constraint (*See* Appendix A). Substituting optimal demand functions for y, l, and t into (2) provides the conditional indirect utility function for Internet access i:

$$U_i^* = \frac{y^o + wT - p_i}{(\phi_1^\sigma + \phi_2^\sigma w^{1-\sigma} + \phi_3^\sigma c_i^{1-\sigma})^{1/1-\sigma}} \qquad (3)$$

where $c_i = w - wa^{\delta_1} x_i^{\delta_2} - a^{\alpha_1} x_i^{\alpha_2}$ is the opportunity cost of time online, and $\sigma = 1/(1 - \rho)$ is the constant elasticity of substitution.

B. Summary

Equation (3) allows conditional indirect utility functions to be obtained for each alternative type of access i, and the household chooses Internet access i when $U_i^* > U_j^*$ for j $\neq$ i. Terms that vary over i (i.e., p_i, f_i, s_i, and r_i) explain the trade-offs faced by households when choosing their optimal Internet access service. As such, (3) gives rise to several propositions which suggest *a priori* signs for economic relationships in the conjoint analysis:

- an increase in the price of access i lowers utility and reduces the likelihood of the household choosing Internet access i;
- always on functionality, speed, and reliability lower the opportunity cost of time online, increase utility, and the likelihood of the household choosing Internet access i; and
- the more skillful the household is in using increased functionality and speed with time online, the greater the price they are WTP for access.

IV. Data and Econometric Method

A. *Survey*

Data for estimating consumer preferences for bundled Internet access attributes are obtained from a nationwide mail survey during September and October 2002. The survey questionnaire comprised of three sections: cognitive buildup; choice task; and demographics. Cognitive buildup asks respondent's 15 questions about their access and use of IT and the Internet, and provides them with information to form preferences about Internet access service. Respondents are then required to evaluate eight choice questions, and provide answers to nine demographic questions. Prior to implementation, the survey questionnaire was pre-tested on ten respondents during May and July 2002, and refined accordingly.

PA Consulting Group administered the survey. Advance postcards describing the survey to residents were mailed on September 3, and an initial survey package (with the questionnaire and incentive) was mailed on September 6. Thank you/reminder postcards were sent on September 13, and follow up surveys on October 3. When the survey was closed on October 25, 378 completed questionnaires were obtained for a response rate of 32 percent, which is about average for surveys of similar length and complexity (Louviere *et al* 2000). The mean completion time for each questionnaire was 26 minutes (n = 322).

B. *Econometric method*

Conjoint analysis is the primary tool used to estimate the demand for Internet access service. Survey respondents answered a series of eight choice questions. Each choice occasion presented a pair of Internet access options, A and B, that differed by five attributes. Respondents indicated their preferred choice. In addition, respondents indicated whether they would switch to the service they had selected if they were already online, or if they would adopt the service selected if they were not (*See* Figure B1 in Appendix B for a choice question example). The parameters of the representative individual's utility function (the marginal utilities of the five attributes) are estimated from observed choices.

Internet access service is described by five attributes.[51] Access is *always on* when no dialup is required for Internet connection, and respondents can use the Internet and place telephone calls at the same time. *Cost* is the fixed monthly price for unlimited usage, ranging from $10 to $85. *Speed* describes the time it takes to receive and send information to and from the home computer. Speed is either very fast for uploads and downloads (*very fast*), or fast for downloads but relatively slower for uploads (*fast*), or same as dial-up (*slow*). Installation of Internet access service can be *immediate*, *within one week*, and *within several weeks*. Finally, *very reliable* Internet access is never disrupted (i.e., there are no service outages); however, with *less reliable* Internet access users may occasionally experience outages that require customer support. Table 1 summarizes the levels of the five attributes.

Table 1. Internet access service attributes

Attribute	Levels
Always on (AO)	1 Always on 2 Not always on
Cost per month (COST)	$10 to $85
Access speed (SPEED)	1 Very fast (download is 20 × dial-up; upload is 20 × dial-up) 2 Fast (download is 10 × dial-up; upload is 5 × dial-up) 3 Slow (same as dial-up)
Installation (INSTALL)	1 Immediately 2 Within one week 3 Within several weeks
Reliability (RELIABLE)	1 Very reliable 2 Less reliable

Theory indicates that respondents maximize their (household's) utility of the service option conditional on all other consumption and time allocation decisions. A linear approximation to the household conditional utility function is:

[51] Theory, received evidence, and industry discussion provided feedback on service descriptions, the definition of attributes, and their levels.

$$U^* = \beta_1 AO + \beta_2 SPEED + \beta_3 COST + \beta_4 INSTALL + \beta_5 RELIABLE + \varepsilon \qquad (4)$$

where the β's are parameters to be estimated, and ε is a random disturbance. Note that the alternative attributes have been coded for econometric estimation so that the expected signs for β_1 through β_5 are negative. For instance, utility is expected to be less when cost increases so $\beta_3 < 0$, but we also expect $\beta_4 < 0$, as higher values for INSTALL imply less desirable outcomes. The hypothetical utility of each service option, U^*, is of course not revealed. Instead, what is known is which option has the highest utility. For example, when a respondent chooses A over B and then the status quo (SQ) over A, it is assumed that $U^*_A > U^*_B$ and $U^*_{SQ} > U^*_A$. Therefore, for this kind of dichotomous choice data, the method of estimation is not linear regression, but rather a form of maximum likelihood analysis called bivariate probit. Essentially, the probability of the outcome for each respondent-choice occasion is written as a function of the data and the parameters (β's). The probability of the entire set of outcomes (all individuals, all choice occasions) is called the likelihood, and this is maximized for choice of the parameters (*See* Appendix C for further description of the estimation method).

Interpretation of the parameters as marginal utilities is the same as a partial derivative: the increase in utility for a one unit increase in the variable. For example, when a less reliable service (RELIABLE = 2) can be made more reliable (RELIABLE =1), utility would increase by β_5 units. Since utility does not have an understandable metric, it is convenient to put this change in dollar terms. This is done by employing the economic construct called willingness to pay. The WTP for a one unit decrease in RELIABLE (the discrete improvement from less to very reliable) can be interpreted as how much more the service would have to be priced to make a consumer just indifferent between the old (cheaper but less reliable) service and new (very reliable) service. The required change in cost to offset an increase of β_5 in utility is, from equation (4), β_5/β_3. This is true for any attribute. The WTP for a one unit improvement in that attribute is the ratio of its marginal utility to the marginal utility of COST.

Individuals may not have identical preferences. An individual's preference toward speed, for example, may differ because of observable demographic characteristics, or may be idiosyncratic. This issue can be examined by estimating (4) on sub-samples of the data. This has the effect of allowing all parameters to be different for individuals in different socioeconomic groups. It is also possible to observe differences in the marginal utility of specific service attributes by interacting those characteristics with demographic variables. For instance, suppose individuals with different levels of education value speed differently. A model that captures this difference is:

$$U^* = \beta_1 AO + (\beta_2 + \eta EDUC) \times SPEED + \beta_3 COST + \beta_4 INSTALL + \beta_5 RELIABLE + \varepsilon \; (5)$$

where η is an additional parameter to be estimated, and EDUC is education.[52] Here, the WTP for a one-unit improvement in speed is β_2/β_3 when education is not important. When education is important, the WTP for a one-unit improvement in speed is now:

$$\frac{(\beta_2 + \eta EDUC)}{\beta_3} \tag{6}$$

and is evaluated at different levels of education.

Finally, an individual's preference toward speed may differ because of unobservable characteristics. One parameterization of this is the random parameters model. For a random speed parameter, for example, the model is:

$$U^* = \beta_1 AO + (\beta_2 + \nu)SPEED + \beta_3 COST + \beta_4 INSTALL + \beta_5 RELIABLE + \varepsilon \tag{7}$$

where ν is a zero-mean, white noise disturbance uncorrelated with the attributes or ε. The additional parameter now estimated is the variance of ν. It is possible to estimate this variance with survey data because there are multiple observations (i.e., choice occasions) for each individual. Mean WTP for an improvement in speed is β_2/β_3, as in the fixed parameter case.

V. Internet Access, Attributes, and Demographics

Before reporting econometric estimates of marginal utilities and WTP from conjoint analysis, survey data are used to examine respondent's access to, and use of, IT and the Internet, their attitude towards various Internet attributes, and demographics.

A. IT, Internet Access and Use

Computers and telephones. 78 percent of respondents have at least one PC or laptop in the home, while 32.6 percent have two or more PCs or laptops in the home. 88.7 percent of respondents have at least one telephone line from the home, and 24.1 percent have a second line. The most frequently sited reason for a second line is "for dial-up Internet access – to free up the primary telephone line for voice calls" (48 percent of homes provide this reason), followed by "work-at-home/home business" (21.4 percent of homes provide this reason). The average price paid per month for a second telephone line is $25.38, which is somewhat higher than estimates of $7.62 per month from Crandall and Jackson (2001), but in the range of $7.70 to $47.62 provided by Hausman *et al* (2001a).

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[52] As shown in equation (3), individual household demographics cannot be included in the utility function (4) as separate arguments since they do not vary across all Internet access alternatives.

Awareness of service availability. Awareness of high-speed service availability is relatively high for cable modem and DSL technology. When asked "which ways of getting high-speed access are available in your neighbourhood," 15.3 percent of respondents replied "not sure" for cable modem, 30 percent for DSL, 64.7 percent for fixed wireless, and 68.2 percent for satellite. 51.3 percent of respondents with no Internet access have high-speed service available in their neighbourhood, as do 80.6 percent of respondents with dial-up access.

Internet access. 71.7 percent of homes connect to the Internet. 71.8 percent of these homes access the Internet with a dial-up connection, two percent use WebTV, and 26.2 percent use a high-speed connection. Survey data suggest that 18.8 percent of the population have a high-speed connection at home.[53] The most frequently sited reason for high-speed Internet access is "speed is appropriate" (34 percent of homes), followed by "I like the always on connection" (24.5 percent of homes), and "to free up my telephone line for voice calls" (24.3 percent of homes).

The mean price per month for dial-up and high-speed access, respectively, is $17.51 and $40.76. These prices are similar to estimates by Glasner (2001), and Ames (2002) at December 2001 of $15 to $25 per month for dial-up, $39.40 for DSL, and $51.67 for cable Internet. Interestingly, survey respondents that have dial-up access and a second telephone line dedicated primarily to dial-up access pay an average price of $45.03 per month to simulate the broadband experience – i.e., $23.75 for dial-up and $21.78 for a second telephone line.

Internet activity and experience. On average, 2.28 household members go online from home for a total of 14.35 hours per week. High-speed users are more active with 19.44 hours of online activity per week compared to dial-up users with 12.55 hours of online activity. Including home, school, work and other locations, high-speed users have been going online for 3.48 years compared to 3.22 years for dial-up users. Further, 63.3 percent of high-speed users have more than five years of online experience, while only 48.2 percent of dial-up users have the same experience. When asked whether they use a high-speed Internet connection at any location outside of the home, 94.6 percent of all respondents (i.e., those with and without Internet access at the home) indicate they have used high-speed Internet at either a cyber café, library, place of employment, school, friend/relative's house, or other location. This suggests a large segment of the population have experienced high-speed Internet access service.

Internet activity data are obtained by asking respondents "how often do you and other household members do each of the following activities: email and instant messaging (IM); use search engines or purchase products; play games or gamble; share music files or photos; banking, trading stocks, or bill payment; and download movies to view on the PC." Table 2 and Table 3 show Internet activity for the most extremes responses, "many time a week", and "never", respectively. Email and IM, and search engines and product purchases are frequent activities for both dial-up and high-speed users, which is consistent

[53] Estimates of PC ownership and Internet access are slightly higher than the BLS (2001) at September 2001 which indicate that 64.4 percent of the population have a computer or laptop in the home, and 51.8 percent connect to the Internet from home.

with findings from the BLS (2001). As suggested above by the number of hours online per week, high-speed users are more active than dial-up users. The percentage of high-speed users answering "many time a week" ("never") is higher (lower) for all Internet activities. High-speed users are two times more likely to share music files and photos, bank, trade stocks, and pay bills many times a week than dial-up users.

Table 2. Frequency of Internet activity – "many times a week"

Activity	All	Dial-up	High-speed
Email & instant messaging	71.4	68.5	79.7
Search engines & purchase products	37.8	29.5	60.8
Play games & gamble	21.0	17.7	30.8
Share music file or photos	10.1	6.8	19.5
Banking, trading stocks, or bill payment	9.8	7.4	16.5
Download movies to view on PC	1.0	0.9	1.3

Note. Cells are percent of respondents using the activity "many times a week."

Table 3. Frequency of Internet activity – "never"

Activity	All	Dial-up	High-speed
Email & instant messaging	2.7	2.7	2.5
Search engines & purchase products	6.4	8.2	1.3
Play games & gamble	51.3	53.2	46.2
Share music file or photos	38.4	42.3	27.3
Banking, trading stocks, or bill payment	52.7	56.7	41.8
Download movies to view on PC	95.3	97.7	88.5

Note. Cells are percent of respondents who "never" use the activity.

Content. Content providers, such as ABC, Cartoon Network, CNN, ESPN, and RealNetworks Inc. are currently working on entertainment packages with games, music, sports and news clips for high-speed Internet users (Grant 2002). Network economics suggests a critical mass of users is required to leverage the complementarity (i.e., positive network effects) between high-speed demand and the provision of entertainment content. Some insight into this relationship is gleamed from the survey question "what would need to change for you to use the Internet to view entertainment video such as a full-length movie or TV show?" Excluding respondents who "would not use their PC and the Internet to view entertainment content", Table 4 shows the most important reason is the "ability to view in convenient location (for instance, your TV in your living room)." "More awareness of how to find interesting content", and "access to a wider range of content" are more important to high-speed users.

Table 4. Change needed to use Internet to view entertainment content

Answer	All	No access	Dial-up	High-speed
Nothing, I would not	46.4	62.5	48.5	30.9
Nothing, I already do	2.3	0.0	1.5	5.9
Ability to view in a convenient location	29.5	20.0	30.5	32.4
Access to a wider range of interesting content	2.6	2.5	2.0	4.4
Better quality picture	4.5	2.5	3.5	8.8
Awareness of how to find interesting content	4.9	5.0	3.0	10.3
Other	9.7	7.5	11.0	7.4

Note. Cells are percent of respondents providing a single answer only.

B. Internet Access Attributes

The "Internet Access Attributes" section of the questionnaire describes and informs respondents about Internet access attributes. Respondents consider their preferences for different attributes when answering the question "how important is (or would be) the attribute of Internet access to you." A single answer is selected for each question from the following choices, "not important", slightly important", "somewhat important", "very important", and "extremely important."

Table 5 shows the percent of respondents who indicate the attribute is either a very important or extremely important part of their Internet access. Speed, reliability, and always on functionality are clearly important to high-speed users. Interestingly, reliability of service is important for respondents with no access, dial-up access, and high-speed access. This latter finding supports anecdotal evidence that consumers desire a service they can count on being available whenever they want to use it, with consistent speed (that is as fast as advertised), and any problems that do arise are immediately handled by good customer service.[54]

Table 5. Importance of Internet access attributes

Attribute	All	No access	Dial-up	High-speed
Always on	49.1	40.3	39.0	87.3
Cost	59.6	48.6	64.6	58.3
Speed	53.6	38.1	46.2	92.4
Installation	33.6	34.2	26.0	54.4
Reliability	66.3	52.0	64.1	89.9

Note. Cells are percent of respondents who indicate attribute is "extremely important" or "very important."

C. Demographics

Survey data provide a profile of the representative household respondent. The average respondent is a white, 50 year old male, with a two year degree at a college or technical school, who resides in a household with 1.7 other members. He was

[54] There may also be concerns about the sustainability of firms in an industry with many recent bankruptcies and company consolidations.

employed last month at a location outside of the home, and has annual household income of $71,934. A description of how Internet access varies by income, race, household size, age, education and employment status is provided below.

Household income. Table 6 shows that Internet access is positively associated with income. 70.6 percent of respondents with household income below $20,000 have no Internet access. Dial-up access is more prevalent for respondents with income ranging from $40,000 to $80,000, and the income group with the most high-speed access is $80,000 or more.

Household size and race. Table 7 indicates that Internet access is more likely in households with two or more occupants, and high-speed access is relatively low for one person households. In Table 8, data provide *prima facie* evidence that Internet access is consumed by at least 50 percent of the population across all racial groups. High-speed access is extremely low for Native Americans and Hispanics. However, any conclusions here should be qualified because of the relatively low number of Native American and Hispanic respondents.

Table 6. Internet access by income

Household income		No access (*n*=57)	Dial-up (*n*=172)	High-speed (*n*=66)
Less than $20,000	(*n*=17)	70.6	29.4	0.0
$20,000 - $39,999	(*n*=53)	32.1	58.5	9.4
$40,000 - $59,999	(*n*=62)	17.7	59.7	22.6
$60,000 - $79,000	(*n*=54)	14.8	74.1	11.1
$80,000 or more	(*n*=109)	8.3	54.1	37.6
Correlation coefficient for linear association between variables			ρ = 0.375*	

Note. Cells are percent of respondents in the access category. * is significant at the five percent level.

Table 7. Internet access by household size

Household size		No access (n=74)	Dial-up (n=210)	High-speed (n=75)
1	(*n*=51)	39.2	54.9	5.9
2	(*n*=148)	23.6	56.1	20.3
3	(*n*=67)	10.4	58.2	31.3
4	(*n*=57)	8.8	68.4	22.8
5 or more	(*n*=36)	19.4	58.3	22.2
Chi-square test for independence of the variables			χ^2 (8) = 26.87*	
Correlation coefficient for linear association between variables			ρ = 0.179*	

Note. Cells are percent of respondents in the access category. * is significant at the five percent level.

Table 8. Internet access by race

Race		No access (n=75)	Dial-up (n=209)	High-speed (n=75)
Asia	(*n*=3)	0.0	66.7	33.3
Native American	(*n*=2)	50.0	50.0	0.0
Black	(*n*=16)	25.0	56.3	18.8
White	(*n*=332)	20.8	57.8	21.4
Hispanic	(*n*=6)	16.7	83.3	0.0

Note. Cells are percent of respondents in the access category.

Household age. Internet access is negatively associated with household age, with Table 9 showing "younger households" are more likely to have Internet access. Further, 42.9 percent of households where the respondent is less than 25 years of age, 24.5 percent of respondents aged from 25 to 34, and 26.4 percent of respondents aged 35 to 44, have high-speed access. This finding is consistent with Carey (1991) and Savage *et al* (1997) who find that younger persons are more open to learning about new technologies such as VCRs, PCs, and broadband.

Table 9. Internet access by age

Age		No access (n=78)	Dial-up (n=217)	High-speed (n=79)
Less than 25	(*n*=14)	21.4	35.7	42.9
25 to 34	(*n*=53)	15.1	60.4	24.5
35 to 44	(*n*=68)	7.4	69.1	23.5
45 to 54	(*n*=87)	11.5	62.1	26.4
55 to 64	(*n*=76)	23.7	63.2	13.2
65 or more	(*n*=76)	44.7	40.8	14.5
Chi-square test for independence of the variables			χ^2 (10) = 47.34*	
Correlation coefficient for linear association between variables			ρ = -0.239*	

Note. Cells are percent of respondents in the access category. * is significant at the five percent level.

Household education and employment status. Table 10 presents Internet access by level of education, and shows a positive association between access and education. A large percentage of respondents with high school education or less do not have Internet access. High-speed access is relatively higher among respondents with college and graduate degrees, perhaps reflecting familiarity with technology, and also a strong recognition of the income and time benefits that can be derived from broadband delivered education and information services. An insignificant χ^2 statistic in Table 11 indicates that employment status is not related to the type of Internet access.

Table 10. Internet access by education

Education		No access (n=77)	Dial-up (n=214)	High-speed (n=77)
Less than high school	(*n*=17)	64.7	11.8	23.5
High school	(*n*=59)	32.2	61.0	6.8
Some college	(*n*=141)	20.6	58.2	21.3
College	(*n*=102)	9.8	65.7	24.5
Graduate degree	(*n*=49)	16.3	55.1	28.6
Chi-square test for independence of the variables			χ^2 (8) = 40.84*	
Correlation coefficient for linear association between variables			ρ = 0.227*	

Note. Cells are percent of respondents in the access category. * is significant at the five percent level.

Table 11. Internet access by employment status

Education		No access (n=33)	Dial-up (n=145)	High-speed (n=51)
Self employed, away from home	(*n*=28)	21.4	42.9	35.7
Self employed, work at home	(*n*=10)	30.0	60.0	10.0
Employed, away from home	(*n*=182)	12.6	67.0	20.3
Employed, work at home	(*n*=9)	11.1	55.6	33.3
Chi-square test for independence of the variables			χ^2 (6) = 9.210	

Note. Cells are percent of respondents in the access category. * is significant at the five percent level.

D. Summary

Survey data show that 78 percent of homes have at least one PC, 72 percent of homes connect to the Internet, and about 19 percent have a high-speed connection. The mean price paid per month for dial-up and high-speed access, respectively, is $17.51 and $40.76.

On average, 2.28 household members go online from home per week. High-speed users go online for 19.44 hours per week, while dial-up users go online for 12.55 hours. 63 percent of high-speed users have more than five years of online experience, compared to 48.2 percent of dial-up users. Email, IM, search, and product purchases are very frequent activities for dial-up and high-speed users. High-speed users are two times more likely to share music files and photos, bank, trade stocks, and pay bills “many times a week” than dial-up users.

Speed, reliability of service, and always on functionality are important to high-speed users. In particular, reliability is important for respondents with dial-up, high-speed, and no access. This finding suggests consumers place great weight on a service they can count on when they want to use it, and has consistent speed with good customer service.

Demographics suggest the average survey respondent is a white, 50 year old male, with a two year degree at a college or technical school, who resides in a household with 1.7 other members. He was employed last month at a location outside of the home, and has household income of $71,934. The type of Internet access chosen is positively associated with household income, size, and education, and negatively associated with household age. Preference for high-speed access is apparent among respondents with higher income and a college education.

VI. *Econometric Estimation and Interpretation*

Section V provides *prima facie* evidence that speed, reliability of service, and always on are important attributes to consumers when considering Internet access. Econometric estimation of utility functions (4), (5), and (7) will provide more precise information on consumer preferences for Internet attributes, and their WTP.

There are 361 usable observations with complete information on the eight choices and the follow-up WTP question . Since each pair of binary choices (A vs. B, and A or B vs. SQ) for each choice occasion represents information on preferences, the starting sample size for econometric estimation is effectively n = 361 x 8 = 2,888. In models where respondent demographic data are used, such as age, education, and income, the sample size is reduced as made necessary by missing values for those variables.

Parameter estimates, asymptotic t-statistics, and WTP calculations for the basic model without respondent heterogeneity for specific attributes are presented in Table 12 and Table 13, respectively. Estimates are reported for the full sample (*All*) and several sub-samples of the data. Sub-samples include:

- respondents with traditional dial-up access through a telephone modem (*With dial-up*);
- respondents with high-speed access (*With high-speed*);
- respondents who are located in areas served by high-speed providers but continue with traditional dial-up access (*Latent high-speed*);
- respondents with college degrees (*College*);
- respondents without college degrees (*Not college*);
- higher income households, i.e., with annual income greater than $60,000; (*Higher income*); and
- lower income households (*Lower income*).

t-statistics are obtained by dividing the mean (marginal effect) parameter by its standard error. A t-statistic of about 2 or more in absolute value indicates with 95 percent or greater confidence that the mean parameter is significantly different from zero. A t-statistic between 2 and 1.6 in absolute value indicates with 90 to 95 percent confidence that the mean parameter is significantly different from zero. For example, in the complete sample (n = 361) the marginal effect of AO (always on) is estimated to be -0.148 with asymptotic t-ratio of -3.93. The t-ratio of –0.148/-0.0376 = -3.93 is greater then two, and indicates that β_1 = -0.148 is statistically significantly different from zero at the five percent level. The estimated WTP to go from not always on to always on service is $5.07, obtained by dividing -1.48 by the estimated parameter on COST of -.029.

The data fit all models well, as judged by the statistical significance of most parameter estimates.[55] In fact, at conventional significance levels of five percent only the coefficient on INSTALL (installation) is not accurately estimated. This parameter is statistically significant only in the not college sub-sample, and has the theoretically wrong sign in the with dial-up, latent high-speed, and college sub-samples. As such, SP data provide no evidence that consumers place any importance on the difficulty of installing Internet access.

Marginal utility parameters for AO, SPEED (access speed), RELIABLE (reliability of service), and COST (cost per month) have signs that are predicted by theory, and are statistically significant. The negative signs imply that individual's

[55] There is no concept of "R^2" for these kinds of models.

relative utility increases when Internet access service is changed from not always on to always on, when access speed is increased, when cost is decreased, and when access is improved from less reliable to very reliable service. In all samples, the most important attribute of Internet access is reliability of service. Consumers are WTP between $13.25 (Latent high-speed) and $39.12 (With high-speed) for more reliable service. Speed is the next most important attribute ranging from $8.22 (Lower income) to $32.15 (With high-speed). Always on is the third most important attribute ranging from $0.91 (With dial-up) to $17.29 (With high speed). Users with high-speed access value all service attributes higher than any others.[56] Those with higher incomes value attributes more highly than those with lower incomes. Those with a college degree value speed more, always on less, and reliability about the same as those without a college degree.

The situation is similar when observed heterogeneity is allowed for by interacting demographic variables with certain attributes. Two models were estimated with interaction variables. One allows EDUC×SPEED and AGE×SPEED interactions. The other model allows an INCOME×COST interaction. Parameter estimates, asymptotic t-statistics, and WTP calculations for the model with respondent heterogeneity for the SPEED and COST attributes are presented in Table 14. WTP for speed increases with education and income, and decreases with age. WTP for the latent high-speed sample (i.e., dial-up users located in areas served by high-speed providers) is less than the WTP for the all household types. For all types, WTP for all attributes increases with income.

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[56] Since high-speed users already have fast or very fast speed, the WTP estimate can be loosely interpreted as a "willingness to accept" concept. That is, $32.15 is the amount high-speed users would be willing to accept as compensation for a downgrade in speed.

Table 12. Parameter estimates, t-statistics, and WTP – by access group

Attribute	All			With dial-up			With high-speed			Latent high-speed		
	β	t-stat	WTP	β	t-stat	WTP	β	t-stat	WTP	β	t-stat	WTP
AO	-0.148	-3.93	$5.07	-0.035	-0.71	$0.91	-0.313	-4.27	$17.29	-0.076	-1.42	$1.87
SPEED	-0.332	-8.17	$11.37	-0.322	-5.89	$8.34	-0.582	-8.00	$32.15	-0.359	-6.06	$8.84
COST	-0.029	-9.03	-	-0.039	-8.76	-	-0.018	-4.39	-	-0.041	-8.51	-
INSTALL	-0.030	-1.31	$1.04	0.035	1.11	-$0.90	-0.014	-0.35	$0.76	0.030	0.89	-$0.73
RELIABLE	-0.483	-12.4	$16.54	-0.546	-9.89	$14.15	-0.708	-8.49	$39.12	-0.538	-9.22	$13.25
n	361 x 8 = 2888			189 x 8 = 1512			75 x 8 = 600			167 x 8 = 1336		

Table 13. Parameter estimates, t-statistics, and WTP – by demographic group

Attribute	College			Not college			Higher income			Lower income		
	β	t-stat	WTP	β	t-stat	WTP	β	t-stat	WTP	β	t-stat	WTP
AO	-0.098	-1.88	$3.67	-0.185	-3.49	$6.13	-0.200	-4.04	$8.16	-0.120	-2.09	$3.45
SPEED	-0.384	-6.61	$14.44	-0.278	-4.92	$9.21	-0.384	-7.27	$15.67	-0.286	-4.56	$8.22
COST	-0.027	-6.10	-	-0.030	-6.56	-	-0.025	-6.19	-	-0.035	-6.73	-
INSTALL	0.041	1.31	-$1.54	-0.077	-2.41	$2.53	-0.048	-1.53	$1.94	-0.007	-0.20	$0.20
RELIABLE	-0.464	-7.58	$17.44	-0.494	-9.68	$16.36	-0.468	-8.66	$19.10	-0.490	-8.68	$14.08
n	149 x 8 = 1192			212 x 8 = 1696			181 x 8 = 1448			180 x 8 = 1440		

Table 14. Parameter estimates, t-statistics, and WTP – interactions

Attribute	All			All			Latent high-speed			Latent high-speed		
	β	t-stat	WTP	β	t-stat	WTP	β	t-stat	WTP	β	t-stat	WTP
AO	-0.141	-3.58	$4.75	-0.160	-3.67	$4.32	-0.072	-1.33	$1.78	-0.082	-1.53	$1.75
SPEED	-0.460	-5.26	see below	-0.392	-8.29	$10.58	-0.019	-0.12	see below	-0.363	-6.10	$7.74
COST	-0.030	-8.85	-	-0.053	-9.41	-	-0.041	-8.45	-	-0.059	-8.64	-
INSTALL	-0.034	-1.45	$1.15	-0.018	-0.69	$0.48	0.0259	0.78	-$0.64	0.032	0.95	-$0.67
RELIABLE	-0.498	-12.4	$16.77	-0.490	-11.00	$13.23	-0.541	-9.21	$13.36	-0.539	-9.20	$11.49
SPEED×EDUC	-0.034	-3.33	-	-	-	-	-0.035	-2.50	-	-	-	-
SPEED×AGE	0.006	4.87	-	-	-	-	-0.0001	-1.15	-	-	-	-
COST×INCOME	-	-	-	0.003	5.72	-	-	-	-	0.002	4.29	-
n	347 x 8 = 2776			347 x 8 = 2776			167 x 8=1336			167 x 8=1336		
	WTP for speed			WTP for speed			WTP for speed			WTP for speed		
	EDUC	AGE	WTP	INCOME		WTP	EDUC	AGE	WTP	INCOME		WTP
	G8	25	$11.72	< $10K		$7.87	G8	25	$1.39	< $10K		$6.44
	HS	25	$14.04	$20K - $30K		$9.03	HS	25	$3.10	$20K - $30K		$7.03
	COL	25	$17.51	$40K - $50K		$10.58	COL	25	$5.66	$40K - $50K		$7.74
	G8	50	$6.80	$60K - $80K		$12.78	G8	50	$1.45	$60K - $80K		$8.61
	HS	50	$9.11	$100K - $150K		$16.14	HS	50	$3.16	$100K - $150K		$9.69
	COL	50	$12.59	> $150K		$18.58	COL	50	$5.73	> $150K		$10.34

Note. G8 is eighth grade education, HS is high school education, and COL is four year college education.

VII. Conclusions

Data obtained from a nationwide mail survey during September and October 2002 are used to construct a profile of residential Internet access, and estimate consumer preferences for bundled attributes. Preliminary analysis of survey data suggests about 19 percent of the population has a high-speed connection, and the mean price paid per month for dial-up and high-speed access is $17.51 and $40.76, respectively. On average, 2.28 household members go online from home per week – 19.44 hours for high-speed users and 12.55 hours for dial-up users. 63 percent of high-speed users have more than five years of online experience, compared to 48.2 percent of dial-up users. Email and IM, and search and product purchases are very frequent activities for dial-up and high-speed users. High-speed users are two times more likely to share music files and photos, bank, trade stocks and pay bills "many times a week" than dial-up users.

Conjoint analysis is the primary tool used to estimate the demand for Internet access service. Internet access was described by a list of attributes, always on connection, cost, speed, installation and reliability. Consumers maximize utility by choosing the service with the best set of attributes. Econometric estimates are used to estimate the willingness to pay for improvements in service attributes. Estimates are obtained for the representative user, as well as users with high and low income, high and low levels of education, by age, and by existing Internet service.

Consumers are willing to pay $13.25 to $39.12 for more reliable service, $8.22 to $32.15 for faster service, and $0.91 to $17.29 for always on connectivity. Generally, consumers do not value ease of installation. High-speed users value all attributes higher than other users, while higher income users value attributes more highly than lower income users. Those with a college degree value speed more, always on less, and reliability about the same as those without a college degree. WTP for speed increases with education and income, and decreases with age. WTP for the latent high-speed sample (i.e., dial-up users located in areas served by high-speed providers) is less than the WTP for the all household types. For all types, WTP for all attributes increases with income.

References

Ames, S. (2002), 'Study: Broadband Fees Climbed in 2001', CNET News.com, January 17, http://news.com.com/2100-1033-818013.html, accessed May 8 2002 8.42 AM MW.

Bakos, J.Y. (2001), 'The Emerging Landscape for Retail E-commerce', *Journal of Economics Perspectives*, 15, 69-80.

BLS (2001), *Current Population Survey: Computer and Internet Use Supplement*, September 2001, www.bls.gov/cps/.

Borenstein, S., and Saloner, G. (2001), 'Economic and Electronic Commerce', *Journal of Economics Perspectives*, 15(1), 3-12.

Bush, G.W. (2002), 'President Discusses the Future Technology at White House Forum', Remarks by the President at the 21st Century High Tech Forum, Presidential Hall Dwight David Eisenhower Executive Office Building, June 2002.

Carey, J. (1991), 'The Market for New Residential Services, in M. Elton (ed.) *Integrated Broadband Networks: The Public Policy Issues*, Elsevier Science, New York.

Cassel, C. (1999), 'Demand for and Use of Additional Lines by Residential Customers', in Loomis, D. and Taylor, L. (eds.) *The Future of the Telecommunications Industry: Forecasting and Demand Analysis*, Kluwer Academic Publishers, Boston.

Compaine, B. (2001), *The Digital Divide: Facing a Crisis or Creating a Myth*, MIT Press, Cambridge, MA.

Crandall, R., and Jackson, C. (2001), *The $500 Billion Opportunity: The Potential Economic Benefit of Widespread Diffusion of Broadband Internet Access*, Criterion Economics, L.L.C. Washington, D.C.

Duffy-Deno, K.T. (2001), 'Demand for Additional Telephone Lines: An Empirical Note', *Information Economics and Policy*, 13, 283-299.

Eisner, J., and Waldon, T. (2001), 'The Demand for Bandwidth: Second Telephone Lines and On-line Services', *Information Economics and Policy*, 13, 301-309.

FCC (2002), *Trends in Telephone Service*, Industry Analysis and Technology Division, Wireline Competition Bureau, Washington, D.C.

FCC (2001), *High Speed Services for Internet Access: Subscribership as of December 31 2001*, Industry Analysis Division, Common Carrier Bureau, FCC, Washington, D.C.

FCC (1998), *The Industry Analysis Division's Reference Book of Rates, Price Indices, and Expenditure for Telephone Service*, Industry Analysis Division, Common Carrier Bureau, FCC, Washington, D.C.

Glasner, J. (2001), 'High Price Just for Speed', Wired News, April 19, www.wired.com/news/business/0,1367,43497,00.html,accessed, April 19 2002 8:35 AM MW.

Grant, P. (2002), 'Comcast Posts Strong Growth in Cable-Modem Subscribers', *The Wall Street Journal Online*, WSJ.com.

Goolsbee, A. (2000), 'The Value of Broadband and the Deadweight Loss of Taxing New Technology', *Mimeo*, University of Chicago.

Hausman, J., Sidak, G., and Singer, H. (2001), 'Cable Modems and DSL: Broadband Internet Access for Residential Customers', *American Economic Review AEA Papers and Proceedings*, 91, May, 302-307.

Jorgenson, D. (2001), 'Information Technology and the US Economy', *American Economic Review*, 91, March, 1-32.

J.P. Morgan (2001), *Telecom Services 2001*, J.P. Morgan Securities Inc., New York.

Litan, R., and Rivlin, A. (2001), 'Projecting the Economic Impact of the Internet', *American Economic Review AEA Papers and Proceedings*, 91, May, 313-317.

Louviere, J., Hensher, D., and Swait, J. (2000), *Stated Choice Methods: Analysis and Applications*, Cambridge University Press, Cambridge, UK.

NTIA (2002), *A Nation Online: How Americans are Expanding Their Use of the Internet*, Department of Commerce, Washington, D.C.

NTIA (2000), *Falling Through the Net: Toward Digital Inclusion*, Department of Commerce, Washington, D.C.

Rappoport, P., Kridel, D., Taylor, L., Duffy-Deno, K., and Alleman, J. (2002), 'Residential Demand for Access to the Internet', in Madden, G. (ed.) *The International Handbook of Telecommunications Economics: Volume II*, Edward Elgar Publishers, Cheltenham.

Röller, L., and Waverman, L. (2001), 'Telecommunications and Economic Development', *American Economic Review*, 91, September, 909-923.

Savage, S.J., Madden, G., and Simpson, M. (1997), 'Broadband Delivery of Education Services: A Study of Subscription Intentions in Australian Provincial Centers', *Journal of Media Economics*, 10, 3-16.

Varian, H. (2002), 'The Demand for Bandwidth: Evidence from the INDEX Project', *Mimeo*, University of California, Berkeley.

Estimating Consumer Demand - Appendix A

Given Internet access i, and assuming CES utility, $F_i = a^{\alpha_1} x_i^{\alpha_2} t$ and $G_i = a^{\delta_1} x_i^{\delta_2} t$, the household optimization problem is:

$$\max_{y,l,t} U_i = (\alpha_1 y^\rho + \alpha_2 l^\rho + \alpha_3 t^\rho)^{1/\rho} \tag{A1}$$

subject to $y_i = y^o + w(T - l_i - t_i + a^{\delta_1} x_i^{\delta_2} t_i) - p_i + a^{\alpha_1} x_i^{\alpha_2} t_i$

The first-order conditions for (A1) are:

$$\alpha_1 y_i^{\rho-1} U_i^{(1-\rho)/\rho} - \lambda = 0 \tag{A2}$$

$$\alpha_2 l_i^{\rho-1} U^{(1-\rho)/\rho} - \lambda w = 0 \tag{A3}$$

$$\alpha_3 t_i^{\rho-1} U^{(1-\rho)/\rho} - \lambda c_i = 0 \tag{A4}$$

$$M - y_i - wl_i - c_i t_i = 0 \tag{A5}$$

where $c_i = w - wa^{\delta_1} x_i^{\delta_2} - a^{\alpha_1} x_i^{\alpha_2}$ is the opportunity cost of time online, and $M_i = y^o + wT - p_i$.

Assuming second-order conditions are met, demand functions are obtained by combining any two equations (A2) through (A4) to eliminate U and λ, and substituting into (A5):

$$y_i^* = \frac{\alpha_1^\sigma M_i}{\alpha_1^\sigma + \alpha_2^\sigma w^{1-\sigma} + \alpha_3^\sigma c_i^{1-\sigma}} \tag{A6}$$

$$l_i^* = \frac{(\alpha_2 / w)^\sigma M_i}{\alpha_1^\sigma + \alpha_2^\sigma w^{1-\sigma} + \alpha_3^\sigma c_i^{1-\sigma}} \tag{A7}$$

$$t_i^* = \frac{(\alpha_3 / c_i)^\sigma M_i}{\alpha_1^\sigma + \alpha_2^\sigma w^{1-\sigma} + \alpha_3^\sigma c_i^{1-\sigma}} \tag{A8}$$

where $\sigma = 1/(1 - \rho)$ is the constant elasticity of substitution.

Substituting (A6) through (A8) into (A1) provides the conditional indirect utility function for Internet access i:

$$U_i^* = \frac{y^o + wT - p_i}{(\alpha_1^\sigma + \alpha_2^\sigma w^{1-\sigma} + \alpha_3^\sigma c_i^{\,1-\sigma})^{1/1-\sigma}} \tag{A9}$$

Estimating Consumer Demand - Appendix B

Figure B1. Choice question example

In a series of questions below, we will ask you to choose between two Internet access options. If you currently have Internet access at home, we also ask if you would actually switch to the Internet access option you have chosen. If you do not currently have Internet access at home, we ask if you would actually adopt the Internet access you have chosen.

Please choose between one of the two options for Internet access, labeled A and B. Each option is described by different levels of the five features. When you know which you prefer, check the box at the bottom of the column. For each question, even if you do not view either A or B as ideal, tell us which you would prefer. ***(To review a description of the features, see page 5).***

21. Check the Internet access option you would prefer. *(even if you do not view either A or B as ideal, tell us which you would most prefer)*

	A	B
Always on	Always on	Not always on
Speed	Slow	Fast
Cost	$25 per month	$45 per month
Installation	Immediate	Immediate
Reliability	Less reliable	Very reliable
Mark X□ for the option you prefer	□-1 I prefer option A	□-2 I prefer option B

22. If you currently have Internet access at home, consider the always on, speed, cost and reliability features of your service. Would you switch to the access option (A or B) you chose above? *(mark one answer)*

❍-1 Yes ❍-2 No

If you do not currently have Internet access at home, would you adopt the access option (A or B) you chose above? *(mark one answer)*

❍-1 Yes ❍-2 No

Small Business and Home Office Demand for Internet Access Service

I. Introduction

The standard theoretical approach to modeling business demand is to employ a production function where broadband is included as an input with capital, labor, land and materials. Cost minimization conditions can be used to derive a conditional input demand function for broadband. However, this aggregated approach is somewhat restrictive when applied to heterogeneous businesses. Like all telecommunication services, high-speed Internet will serve a wide range of internal and external business needs, some are complementary to their inputs while other are substitutes, and some are related to productions while others are related to marketing. Viewing high-speed access as a single input may not capture the real structure of business telecom demand (Taylor 1994). Given such difficulties, less rigorous empirical methods are useful for examining business demand for high-speed access. Here, some understanding of small business attitudes and demand for broadband are gleamed from existing studies in Section II, and analysis of survey data and firm demographics (or "firmographics") in Section III. Conclusions are provided in Section IV.

II. Previous Studies of Business Demand

Madden *et al* (2000) survey 65 small business respondents in rural Western Australia in November 1998 to obtain estimates of latent demand for broadband. Survey data is collected from 18 farmers, 37 small businesses, and 10 home offices in small towns (less than 500 persons) during the period October 1 through November 5 1998. Almost 90 percent of respondents are aware of the availability and potential benefits from high-speed delivered communication and information services. On average, business respondents are prepared to spend $63 per month for broadband, and this expenditure increases with monthly sales revenue. An OLS regression of broadband expenditure on geographical, information and technology variables shows businesses with a least one computer are willing to spend 18 percent more for high-speed access, and spend increases by $0.56 for every 100 km distance between business location and a provincial centre. Madden *et al* conclude that distant business populations have strong information needs and latent demand for high-speed services. They suggest carrier aversion to providing high-speed access and services to small business and farms in rural regions may not be justified on commercial grounds.

J.P. Morgan (2001) track public telecom service companies by quarter and forecast US Internet traffic growth to fall from 128 percent in 2000 to 51 percent in 2006. They expect the mix of traffic to change substantially during this period. In particular, there will be a decline in web page generated traffic and increases in streaming media. The share of peer-to-peer traffic should remain steady driven by larger email attachments and longer 'to' lists. Business demand for high-speed lines is forecast to increase from 579,000 lines in 2000 to 4,696,000 lines in 2006. In terms of market share, cable should make up about 2.4 percent of business high-speed lines, DSL will have 94.7 percent, and fixed wireless and satellite the remainder.

The business share of total high-speed lines will remain steady over the period at about 10 percent, but their share of high-speed revenue generated by business subscribers will increase from 13.8 percent in 2000 to 17.1 percent in 2006.

Dun and Brandstreet (2002) examine computer and Internet use for businesses with 25 or fewer employees. A survey of 543 respondents during March/April 2002 obtains small business firmographics, and asks questions about the perceived benefits from employee access to the Internet and their activities. 85 percent of respondents indicate ownership of at least one computer, and 71 percent have at least one employee with Internet access. Of those small businesses with computer and Internet access, 52 percent provide Internet access to all employees, with home-businesses, real estate and businesses who primarily serve commercial accounts more likely to report Internet access for all employees.[57] Most Internet connections are made through dial-up telephone modems (51 percent), followed by DSL (19 percent) and cable modems (11 percent). Dial-up was most prevalent among manufacturers and wholesalers with relatively low sales revenues of fewer than $50,000 per month. DSL connections are popular among the business service and transport sectors, and small businesses with monthly revenue greater than $50,000. The most prevalent Internet activities for small business are e-mail, business research and online purchases, and personal research. Video-conferencing through the Internet increased substantially to five percent of businesses in 2002, albeit from a very low base of one percent of business respondents in 2000.

III. Business Survey Data

A profile of small office-home office (SOHO) and small business (SBUS) access and use of the Internet is developed from In-Stat/MDR (2002) survey data. Associated firmographics describe the type of firms surveyed, their size, and the job descriptions of persons completing the survey questionnaire. In-Stat/MDR surveyed 326 business Internet end-users in March 2001. Survey respondents do not provide high-speed services to residences or other businesses, and have no plans to do so in the near future. Further, respondents have plans to purchase high-speed services during the period April 1 2001 to March 31 2002. About 94 percent of surveyed businesses are located in the US representing 38 states and the District of Columbia.

Business users are divided into three categories by number of employees. SOHOs employ 1 to 4 persons, SBUSs employ 5 to 99 persons, and middle market and enterprise (MME) businesses employ 100 or more persons. Inclusion of MMEs in the sample provides a natural benchmark for comparing SOHO and SBUS use of the Internet and their attitudes toward broadband. 16.7 percent of the sample population is SOHOs, 44.6 percent are SBUSs, and 38.6 percent are MMEs. For the sub sample of SBUS end-users, 46.1 percent employ 5 to 19 persons, 25.5 percent employ 20 to 49 persons, and 28.4 percent employ 50 to 99 persons. Communications and services are the primary industry for SOHOs, communications, services, and manufacturing are the primary industry for SBUSs, and communications, manufacturing, services, finance, insurance and real estate are the primary industry for MMEs. Job descriptions for employees responding to the survey vary across business categories. Survey questionnaires are typically completed by the president (CEO, chairperson, owner, etc.) of SOHOs, the president or vice-president of SBUSs, and the vice-president, information technology (IT) executive, or IT staff

[57] When asked whether the company would benefit when all employees have Internet access only 11 percent said yes. Reasons given are “no need for it,” “employees that need it, have it,” “would not help business,” “do not want employees to have it,” and “employees are in the field.”

member for MMEs. All 326 SOHO, SBUS, and MME respondents are directly involved in broadband purchase decisions for their respective businesses.

A. *Internet Awareness and Availability*

Table 1 shows that business's interpretations of "what is broadband" are similar across all business categories for most types of Internet access. A noticeable difference is fixed wireless. Only 26.42 percent of SOHO respondents consider fixed wireless to be broadband compared to 51.77 percent and 44.26 percent for SBUS and MME, respectively.

Table 1. Interpretation of broadband access by business

Access	SOHO (n=53)	SBUS (n=141)	MME (n=122)
3G wireless	28.30	39.72	33.61
56kbps dial-up	0	1.42	1.64
ATM	39.62	49.65	49.18
Cable modem	79.25	83.69	83.61
DSL	86.79	90.78	86.07
Fixed wireless	26.42	51.77	44.26
Frame relay	26.42	31.91	40.98
ISDN	33.96	24.11	31.15
T1	67.92	72.34	73.77

Note. Cells are percent of respondents who interpret the method of access as broadband.

As indicated in Table 2, DSL is the most preferred method of broadband Internet access for all businesses, followed by T1 lines, and cable modem access. SBUSs and MMEs have no preference for dial-up access, and dial-up is preferred by only 1.89 percent of SOHOs. Table 3 suggests that all business types are reasonably well aware of the alternative Internet access options available in their area. Relatively low awareness of 3G wireless options (3.77 percent of SOHOs, five percent of SBUSs, and 4.92 percent of MMES) could reflect either lack of awareness and/or lack of availability. Given the high level of marketing and promotion directed towards dial-up, cable modem, DSL and T1 technologies, a high awareness of these options is encouraging. However, a high awareness of cable modem access for SBUS (75.71 percent) and MMEs (79.51 percent) is surprising given relatively low levels of broadband cable deployment in business and commercial areas.

Table 2. Preferred method of Internet access by business

Access	SOHO (n=53)	SBUS (n=140)	MME (n=121)
3G wireless	1.89	2.86	4.96
56kbps dial-up	1.89	0	0
ATM	3.77	7.14	5.79
Cable modem	13.21	11.43	12.40
DSL	43.40	32.86	26.45
Fixed wireless	5.66	6.43	7.44
Frame relay	1.89	2.14	2.48
ISDN	1.89	1.43	0.83
T1	18.87	23.57	25.62
Other	7.55	12.14	14.05

Note. Cells are the percent of respondents who prefer the listed method of Internet access.

Table 3. Awareness of Internet access options by business

Access	SOHO (n=53)	SBUS (n=141)	MME (n=122)
3G wireless	3.77	5.00	4.92
56kbps dial-up	81.13	81.43	74.59
ATM	22.64	44.29	54.92
Cable modem	73.58	75.71	79.51
DSL	81.13	86.43	85.25
Fixed wireless	15.09	35.00	25.41
Frame relay	37.74	57.14	63.11
ISDN	60.38	77.86	77.05
T1	66.04	80.00	86.89

Note. n is number of observations. Numbers are the percent of respondents who are aware that the listed method of Internet access is available in their area.

B. *Service Provision*

Table 4 summarizes firm's impression of which companies and service providers are most capable of providing broadband access. Responses are fairly similar for all business categories with respect to a cable company, wireless provider, ISP, and inter-exchange carrier (IXC). SOHOs appear to be less comfortable with the capability of LECs and CLECs relative to SBUSs and MMES.

Table 4. Most capable broadband provider by business

Access provider	SOHO (n=53)	SBUS (n=141)	MME (n=122)
Cable company	55.77	47.14	51.64
Wireless provider	19.23	17.14	20.49
ISP	34.62	40.00	47.54
IXC	50.00	48.57	57.38
LEC	21.15	35.00	44.26
CLEC	38.46	50.00	47.54
Other	0	5.00	2.46

Note. Cells are percent of respondents who believe the listed access provider is capable of providing broadband access.

Table 5 indicates the most important reason why SOHOs, SBUSs and MMEs select a broadband provider. Availability of service is frequently sited for SOHOs, SBUSs and MMEs, which implies substantial latent demand for broadband. Besides availability, monthly cost, quality of service guarantees, and good customer service are the most important reasons why SOHOs choose a particular broadband service provider. By contrast, SBUSs and MMEs place more importance on quality of service guarantees than the monthly cost of broadband access. While Table 5 provides *prima facie* evidence that the most important reason for broadband service provider selection varies across SOHOs, SBUSs and MMEs, the χ^2 statistic does not reject the null of independence between important reason and business. Nevertheless, it is possible to conclude that cost, customer service and quality of service guarantees together are important features to all business when choosing a broadband access option and provider.

Table 5. Reason for broadband provider selection by business

Most important reason	SOHO (n=52)	SBUS (n=141)	MME (n=122)
Provider reputation	1.89	3.55	4.10
Breadth of services	1.89	6.38	6.56
Availability	20.75	26.95	27.05
Availability of bundled services	7.55	7.09	7.38
Monthly cost	22.64	16.31	10.66
Affordable installation cost	1.89	1.42	0.82
Good customer service	15.09	10.64	9.84
Quality of service	18.87	24.82	28.69
Other	9.43	2.84	4.92
$\chi^2(16) = 12.688$, Probability value = 0.6955			

Note. Cells are percent of respondents for whom the listed reason is most important in their broadband purchase decision. χ^2 tests the null hypothesis of independence of the two variables. Probability value ≤ 0.05 rejects the null at the five percent level.

Table 6 lists potential barriers to the purchase of broadband by business category. There are a large number of responses in the “other category” which suggests further research is required to uncover important barriers to broadband uptake other than those listed. Besides other, the most frequently cited response is that no barriers exist. Further, very few respondents state they are not interested, or have no need, for broadband. Perceived value is very important to businesses with monthly costs and low service reliability the greatest barriers to purchasing broadband for SOHOs, SBUSs and MMEs. Examination of Table 5 and Table 6 responses together indicates that all businesses are both interested and willing to purchase broadband when service packages emphasize cost and reliability of service.

Table 6. Barriers to broadband purchase by business

Most important barrier	SOHO (n=53)	SBUS (n=139)	MME (n=120)
Equipment cost	7.55	2.88	5.00
Installation cost	1.89	2.88	1.67
Low service reliability	11.32	15.11	14.17
Monthly cost	24.53	28.06	20.83
Need to install network	3.77	1.44	4.17
Security concerns	3.77	3.60	6.67
Training users	0	0.72	1.67
Not interested, no need	0	0	1.67
Other	16.98	13.67	22.50
No barriers exist	28.30	30.94	21.67
Don't know	1.89	0.72	0

Note. Cells are percent of respondents for whom the listed barrier is their greatest barrier to purchasing broadband.

C. *Important Activities, Applications and Functions*

Table 7 describes the importance of broadband access to business success in 2002. More than 90 percent of respondents for all three business categories believe broadband is critical or important to their business success. Awareness of the emerging digital economy is reflected to some extent in number of 'not at all important' responses. No SOHO, SBUS, or MME respondents indicate that broadband is not at all important to their success.

Table 7 Broadband and success by business

Importance to success in 2002	SOHO (n=53)	SBUS (n=138)	MME (n=117)
Critical	67.31	63.04	58.12
Important, but not critical	25.00	32.61	37.61
Somewhat important	3.85	3.62	4.27
Not very important	3.85	0.72	0
Not at all important	0	0	0

Note. n is number of observations. Numbers in table are percentage of respondents who believe broadband is critical, important, … , etc., to their firm's success in 2002.

Table 8 through Table 11 focus on how important features such as always on, access speed, delivery of integrated service, and remote access are in driving broadband demand. Table 8 shows that over 80 percent of respondents for all business categories consider always on to be critical or important in driving their decision to subscribe to broadband. Only 3.77 percent of SOHOs, 0.71 percent of SBUSs and 1.67 percent of MMEs indicate always on is not at all important. A χ^2 statistic rejects the null of independence between always on and business, and suggests the importance of always on to broadband uptake varies across business categories.

Table 8 Always on functionality as a broadband driver by business

Importance of always on	SOHO (n=53)	SBUS (n=140)	MME (n=120)
Critical	54.72	73.57	47.50
Important, but not critical	26.42	21.43	30.00
Somewhat important	11.32	3.57	17.50
Not very important	3.77	0.71	3.33
Not at all important	3.77	0.71	1.67
$\chi^2(8) = 26.739$, Probability value = 0.0008			

Note. Cells are percent of respondents who believe always on is a critical, important, … , etc., driver of broadband uptake. χ^2 tests the null hypothesis of independence of the two variables. Probability value ≤ 0.05 rejects the null at the five percent level.

As indicated in Table 9, over 85 percent of business respondents consider access speed to be a critical or important feature that will drive their decision to take up broadband. No respondents in any business category site speed as being not at all important.

Table 9 Internet access speed as a broadband driver by business

Importance of access speed	SOHO (n=53)	SBUS (n=140)	MME (n=121)
Critical	54.72	65.00	48.76
Important, but not critical	33.96	27.86	38.02
Somewhat important	9.43	7.14	12.40
Not very important	1.8	0	0.83
Not at all important	0	0	0

Note. Cells are percent of respondents who believe speed is a critical, important, … , etc., driver of broadband uptake.

Table 10 suggests integrated delivery of data, voice and video services is a less important broadband driver than always on and access speed. Further, integrated service delivery are more important to SBUSs and MMEs, respectively, with about 42 percent of SBUSs and 47 percent of MMEs stating that this function is critical or important, compared to 32 percent of SOHOs. A χ^2 statistic rejects the null of independence between integrated service delivery and business, and suggests a relationship between the importance of integrated service delivery to broadband uptake and business category.

Table 10 Integrated service as a broadband driver by business

Importance of integrated data, voice, and video delivery	SOHO (n=50)	SBUS (n=137)	MME (n=120)
Critical	24.00	13.87	14.17
Important, but not critical	8.00	28.47	33.33
Somewhat important	26.00	25.55	30.83
Not very important	26.00	20.44	13.33
Not at all important	16.00	11.68	8.33
$\chi^2(8) = 7.420$, Probability value = 0.0260			

Note. Cells are percent of respondents who believe integrated service is a critical, important, … , etc., driver of broadband uptake. χ^2 tests the null hypothesis of independence of the two variables. Probability value ≤ 0.05 rejects the null at the five percent level.

Like integrated service delivery, the ability to run applications remotely over the Internet is a less important driver of broadband uptake than always on and access speed. Table 11 shows that 52 percent of SBUSs and 61 percent of MMEs believe the running of applications remotely over the Internet is a critical or important driver of broadband uptake, compared to 43 percent of SOHOs. About 21.6 percent of SOHOs indicate that remote access is not at all important, perhaps reflecting the fact that they are small business based out of home and have fewer employees away from the central office location. A χ^2 statistic rejects the null of independence between remote access and business, and suggests the importance of remote access to broadband uptake and business category are interrelated.

Table 11 Remote access as a broadband driver by business

Importance of remote access	SOHO (n=51)	SBUS (n=139)	MME (n=120)
Critical	21.57	25.90	35.00
Important, but not critical	21.57	26.62	25.83
Somewhat important	15.69	26.62	24.17
Not very important	19.61	12.23	10.00
Not at all important	21.57	8.63	5.00
$\chi^2(8) = 18.494$, Probability value = 0.0260			

Note. Cells are percent of respondents who believe remote access is a critical, important, … , etc., driver of broadband uptake. χ^2 tests the null hypothesis of independence of the two variables. Probability value ≤ 0.05 rejects the null at the five percent level.

Table 12 through Table 15 provide insight into the importance placed on individual Internet activities and applications in driving broadband uptake. As shown in Table 12, email, IM and other messaging applications are important drivers of broadband across all business categories. 83.02 percent of SOHOs, 82.98 percent of SBUSs and 77.5 percent of MMEs indicate that messaging activities are critical or important in driving their business's need for broadband.

Table 12 Email and IM as a broadband driver by business

Importance of email and IM	SOHO (n=53)	SBUS (n=141)	MME (n=120)
Critical	54.72	60.28	49.17
Important, but not critical	28.30	22.70	28.33
Somewhat important	9.43	9.93	20.00
Not very important	5.66	4.96	1.67
Not at all important	1.89	2.13	0.83
$\chi^2(8) = 11.182$, Probability value = 0.1916			

Note. Cells are percent of respondents who believe email and IM are critical, important, … , etc., drivers of broadband uptake. χ^2 tests the null hypothesis of independence of the two variables. Probability value ≤ 0.05 rejects the null at the five percent level.

Both Table 13 and Table 14 indicate that e-commerce and streaming media are important to driving broadband uptake. 53.06 percent of SOHOs, 48.92 percent of SBUSs and 49.14 percent of MMEs indicate that e-commerce is critical or important in driving their business's need for broadband. 42.31 percent of SOHOs, 45.34 percent of SBUSs and 38.66 percent of MMEs state that streaming media is a critical or important factor in driving their demand for broadband.

Table 13 E-commerce as a broadband driver by business

e-commerce	SOHO (n=49)	SBUS (n=139)	MME (n=122)
Critical	22.45	23.02	18.03
Important, but not critical	30.61	25.90	31.15
Somewhat important	26.53	23.02	30.33
Not very important	12.24	18.71	12.30
Not at all important	8.16	9.35	8.20
$\chi^2(8) = 5.0471$, Probability value = 0.7525			

Note. Cells are percent of respondents who believe streaming media is a critical, important, … , etc., driver of broadband uptake. χ^2 test the null hypothesis of independence of the two variables. Probability value ≤ 0.05 rejects the null at the five percent level.

Table 14 Importance of streaming media as a broadband driver by business

Streaming audio and video	SOHO (n=52)	SBUS (n=139)	MME (n=119)
Critical	23.08	14.39	13.45
Important, but not critical	19.23	30.94	25.21
Somewhat important	26.92	27.34	31.93
Not very important	19.23	17.99	19.33
Not at all important	11.54	9.35	10.08
$\chi^2(8) = 5.2910$, Probability value = 0.7261			

Note. Cells are percent of respondents who believe streaming media is a critical, important, … , etc., driver of broadband uptake. χ^2 test the null hypothesis of independence of the two variables. Probability value $\leq$ 0.05 rejects the null at the five percent level.

Finally, Table 15 shows how businesses view video-conferencing as a driver of broadband demand. Video-conferencing appears to be less important than messaging, e-commerce and streaming media. About 44.5 percent of SBUSs and 43 percent of MMEs believe video-conferencing through the Internet is a critical or important driver of broadband uptake, compared to 30 percent of SOHOs. 20.9 percent of SBUSs indicate that video-conferencing is not at all important. A χ^2 statistic rejects the null of independence between video-conferencing and business, and suggests the importance of video-conferencing to broadband uptake and business category are interrelated.

Table 15 Video-conferencing as a broadband driver by business

Video-conferencing	SOHO (n=50)	SBUS (n=139)	MME (n=121)
Critical	18.00	12.23	11.57
Important, but not critical	12.00	22.30	31.40
Somewhat important	34.00	27.34	29.75
Not very important	28.00	17.27	16.53
Not at all important	8.00	20.86	10.74
$\chi^2(8) = 16.780$, Probability value = 0.0325			

Note. Cells are percent of respondents who believe video-conferencing is a critical, important, … , etc., driver of broadband uptake. χ^2 tests the null hypothesis of independence of the two variables. Probability value $\leq$ 0.05 rejects the null at the five percent level.

IV. Conclusions

A profile of small office-home office and small business access and use of the Internet is developed from In-Stat/MDR (2002) survey data and associated firmographics.

Data suggest that always on connectivity and speed are critical or important in driving business toward broadband subscription. Integrated delivery of data, voice and video services is a relatively less important broadband driver to SOHOs than always on and speed. Like integrated service delivery, the ability to run applications remotely over the Internet is a less important driver of broadband uptake than always on and access speed. A relatively large percent of SOHO respondents (about 22 percent) indicate that remote access is not at all important, perhaps reflecting the fact that they are small business based out of home and have fewer employees away from the central office location.

Further analysis provides insight into the importance placed on individual Internet activities and applications in driving broadband demand. E-mail, IM and other messaging applications, e-commerce, and streaming media are important drivers of broadband across all business categories. However, the degree of importance is not related to the type of business.

Video-conferencing appears to be less important than messaging, e-commerce and streaming media, and less important o SOHOs and SBUSs compared to MMEs.

References

Dun and Brandstreet (2000), *D&B 21st Annual Small Business Survey Summary Report*, http://sbs.dnb.com/Default.asp?referrer=sbsnavcenter&bhcd2=1026313941.

In-Stat/MDR (2002), Survey Data for US Business Markets, www.instat.com.

J.P. Morgan (2001), *Telecom Services 2001*, J.P. Morgan Securities Inc., New York.

Madden, G., Savage, S.J., Coble-Neal, G., and Bloxham, P. (2000), 'Advanced Communications Policy and Adoption in Rural Western Australia', *Telecommunications Policy*, 24, 291-304.

Taylor, L. (1994), *Telecommunications Demand in Theory and Practice*, 2nd edition, Kluwer Academic Publishers, Boston.

US Government use of Broadband

3. *What extent the U.S. Government is currently a subscriber of broadband services, and if increased Government use of broadband can motivate higher subscription rates among residences and businesses?*

SUMMARY

Initial results at ascertaining Government connectivity are moderate, creating only a general view. We believe follow up surveys could shed some more light on this topic. However, based on conversations with officials within US agencies, it is not clear that the government understands the relevant concepts.

We found a great deal of information indicating that the government is indeed looking at ways of improving efficiency and reduced costs through the use of Information and Communication Technology (ICT). However, these efforts do not focus specifically on broadband services per se. We did find the terms "broadband", "high speed" and "high rate" in numerous federal reports concerning such things as telework, work process, ecommerce and egovernment. We also found a number of reports and proposed legislation that mentioned the role of broadband as a general driver of economic growth.

While we do believe that government should look at the role of broadband, we also believe that this is just one part of a much bigger effort; that of understanding how all of ICT can help government be more efficient and cut costs. Nonetheless, it may be worthwhile for industry to demonstrate to government why they should look more closely at the role of broadband. For example, the conclusions reached in this document could be used as a launching point for more in depth investigation by a government agency, such as GAO.

As for Government driving broadband internally and externally, they are moving in the right direction. Instead of finding the killer app, they are slowly developing accessible, reliable and user-friendly services and applications to better serve their own and their citizen's needs. We recommend to developers focus on current ICT projects that will most likely evolve into useful bundled applications and services, rather than attempt to identify the next best thing. We also recommend that government continue to focus on telecommuting, improved online business process, and accessible portals.

In this section, we address to what extent the U.S. Government is currently a subscriber of broadband services, and if increased Government use of broadband can motivate higher subscription rates among residences and businesses.

To facilitate this research, we investigated the following:

1. How many broadband connections do U.S. Government agencies and departments subscribe to? How are these geographically distributed?

2. What internal Government applications could be implemented to stimulate the Government's need for and use of broadband services?

3. Has the government effectively evaluated broadband services and applications as tools for increasing efficiency and reducing costs?

4. What online services and applications could be implemented to improve or add value to Government service to citizens and businesses via broadband access, and thus motivate them to subscribe to broadband?

The following is the findings of our work in this space.

How many broadband connections do U.S. Government agencies and departments subscribe to? How are these geographically distributed?

Specific numbers on Government connectivity are elusive. We researched reports and studies from Government agencies and departments, but none had the level of detail we required. In communication with the Office of Management and Budget, we learned that to perform this level of analysis, the OMB would require agencies to report their use of broadband as a business case, which was not the case for FY2003 reporting requirements.[58] Inquiries to other agencies and departments, including the General Services Administration and the General Accounting Office, produced similar responses.

While no report or study has been completed at this time on Government connectivity, this information can be extrapolated from existing government sources. The problem we found was the contradictions among the sources. We made attempts at contacting the Chief Information Officers of the Federal Agencies as listed by the Chief Information Office Council to solicit further information. There responses were not helpful. A sampling technique may turn out to be the only way to gather this information. We tried making use of online databases that indicate where (and in what number) federal employees are located.[59] However, we found contractions within the numbers, suggesting that the information may be less than valid.

We were able to ascertain that nearly all federal agencies have their desktop computers wired to a LAN to share files. These networks connect to the Internet, using a T-1, T-3 or higher connection, so that computer users have direct access to the Internet and all of its resources.[60] We believe investigating the Government's method of telecommunications procurement may prove beneficial in ascertaining connectivity information.

It is worth noting that for the past several years, agencies have bought long-distance, local and data services from a multitude of companies, but through very few contracts.

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[58] Electronic communications with William McVay, US office of Management and Budget

[59] http://www.opm.gov/feddata/index.htm

[60] Carney, Untitled, Federal Computer Week, http://www.fwc.com

The General Services Administration's Federal Technology Service runs telecom contracts for most agencies, and pre-negotiates the rates and terms of those agreements. The FTS dominates the government telecom market.[61] A challenge to the FTS position is GovWorks, the fee-for-service acquisition department of the Interior Department's Minerals Management Service. The GovWorks model lets telecom vendors design contracts in consultation with individual agencies, as opposed to the FTS model that sets terms and then offers them up to agency customers. Identifying all the Government's methods for obtaining telecom services might allow one to better understand the dynamics of upgrading connectivity.

Likely the most relevant connectivity data comes from the Government's push for teleworking. Our research found over 75% of Federal teleworkers are using dial-up connections to connect to their agency networks and 19% use some form of high-speed connection. Of these teleworkers, network connectivity is rated as the most serious performance issue, and the need for broadband connections will increase as telework becomes more prevalent and frequent.[62] This will provide opportunity for service providers to contract with the Government.

Interestingly, there is documentation within OPM that suggests a teleworker does not need computer connectivity, let alone a broadband connection, to be an effective teleworker. While this may be the case, such statements should be supported with the appropriate research and method of application to the individual task done by that teleworker.

What internal Government applications could be implemented to stimulate the Government's need for and use of broadband services?

Security, eGovernment, and telecommuting are driving an increase in Federal spending on telecommunications products and services. Market research predicts an 8 percent annual growth in spending from $10.8 billion in 2002 to $16.1 billion in 2007.[63]

We first reviewed current Federal IT programs and applications to assess their use of broadband. The most ambitious of all the Federal Governments IT projects is its eGovernment strategy. Comprised of 24 initiatives, the eGovernment project attempts to improve the quality of service for citizens and Government employees. Accessing services or information should take minutes or hours, versus today's standard of days or weeks. Citizens, businesses and state and local governments will be able to readily file required reports. Government employees will be able to do their work more easily, efficiently and effectively.[64]

Also of interest for us are the initiatives concerning Government-to-Government (G2G) and Internal Efficiency and Effectiveness (IEE). G2G Make it easier for states and localities to meet reporting requirements and participate as full partners with the federal government in citizen services, while enabling better performance

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[61] Harris, Shane. "Tech insider: A new dawn in telecommunications?" Federal Computer Week, http://www.fwc.com, March 11, 2002

[62] "Analysis of Home-Based Telework Technology Barriers, Final Report on Technology Barriers to Home-Based Telework," US General Services Administration, www.gsa.gov

[63] "Fed Telecom booms", http://www.Washingtontechnology.com, June 17, 2002

[64] Office of Management and Budget, E-Government Strategy, http://www.omb.gov

measurement, especially for grants. Other levels of government will see significant administrative savings and will be able to improve program delivery because more accurate data is available in a timely fashion.

The IEE initiatives make better use of modern technology to reduce costs and improve quality of federal government agency administration, by using industry best practices in areas such as supply-chain management, financial management and knowledge management. Agencies will be able to improve effectiveness and efficiency, eliminating delays in processing and improving employee satisfaction and retention.

While these initiatives are a good start, they do not require substantial bandwidth to operate. This is not to say these are irrelevant to the goal of improving broadband deployment, as these initiatives lay a foundation and provide certain functionality required of other broadband applications. Once functional, new applications can be added that may require more bandwidth.

Two projects closely associated with the eGovernment initiative, GovNet and the XML initiative, are important to address for their potential as broadband starters. GovNet is being developed as a highly secure and reliable internal network for the Government to share information between agencies. This private intranet will have VOIP and video capability requiring high bandwidth.[65] If developed, it is likely that this high bandwidth backbone will eventually build out to all agencies nationwide.

The XML initiative is aiming to improve internal efficiency by standardizing data across all agencies. This will allow for faster and easier data retrieval across Government.[66] What makes it so attractive is its ability to be read across dissimilar computer systems – heterogeneity is the case for most of the Federal Government. XML will interconnect agencies in new ways and foster new cross agency applications that, as IT spending increases, will drive broadband demand. We believe the lesson here is that if interagency communication improves by creating more interoperable content, there will be a demand for higher rate interconnectivity.

As noted earlier, we have found a tremendous amount of information on telecommuting. A study performed by the United States Office of Personal Management found agencies reported 74,487 federal teleworkers as of October 1, 2001.[67] Since the majority of these workers use dial-up, this represents an opportunity for increasing broadband penetration. The need is for the Federal government to find broadband a useful requirement for its teleworkers.

We see the use of telecenters, remote office locations equipped with PCs, tech support, and communications links, will be a steppingstone for the development of telework and broadband. Telecenters act like training wheels for individuals not used to or ready to work remotely. The confidence and ease of use gained from using these broadband capable telecenters will drive teleworkers to demand broadband to their homes. The use of telecenters also serves as a means of promoting awareness of broadband, a key ingredient to adoption. The use of telecenters has been lukewarm at best, but the

65 Delio, Michelle, "GovNet: What is it good for?" http://www.wired.com, January 21, 2002

66 Matthews, William, "Is XML too prolific?" Federal Computer Week, http://www.fcw.com, July 01, 2002

67 "The Status of Telework in the Federal Government," Produced by the United States Office of Personal Management, http://www.telework.gov/status-toc.htm

OPM and GSA are developing programs to encourage the use of these locations.[68]

While all of these initiatives are a step in the right direction, many are not explicitly bandwidth drivers. But, they are important as a platform in which broadband can be built from at a later time. To drive broadband internally in the near future, we believe the adoption of videoconferencing, the online work process, e training, and VoIP is necessary.

Has the government effectively evaluated broadband services and applications as tools for increasing efficiency and reducing costs?

We found a great deal of information indicating that the government is indeed looking at ways of improving efficiency and reduced costs through the use of information and communication technology (ICT). However, these efforts do not focus specifically on broadband services per se. In fact, we could not find any government study that looked specifically at broadband as a tool to increase efficiency or reduce costs. We did find the term "broadband" and "broadband applications" in numerous federal reports concerning such things as telework, work process, ecommerce and egovernment. We also found a number of reports and proposed legislation concerning the role of broadband as a general driver of economic growth.

Much of the general ICT work is focused within a few (although important) agencies including, Office of Personal Management (OPM), Office of Management and Budget (OMB), General Accounting Office (GAO) and Government Services Administration (GSA). Another key player in this area is Congress through its legislative efforts. Therefore, to assess the degree to which the government is looking into the use of broadband, we consider both government sponsored initiatives (such as that of GAO, GSA, OMB, and OMP) and congressional legislation (such as the e-government Bill S.803).

Among the government efforts that did consider the role of broadband we found the following:

- Telecommuting/Telework
- Paperwork Elimination Act
- OMD's 24 egovernment initiative
- Presidential statements
- Senate Bill 803 on egovernment
- Other agency and legislative efforts

We are continuing to look for other studies that may have been done by (or for) government concerning the role of broadband as a means of increasing efficiency.

We now consider each of the initiatives identified above.

TELECOMMUTING/TELEWORK

One area where we did find consideration of broadband was within the federal government efforts to encourage telecommuting/teleworking. While government does not believe that telecommuting explicitly requires broadband, we did find reference to broadband as a platform for improving the telework experience.[69] We will not consider the role of telecommuting any further within this section in that it is covered is great detail elsewhere in this report.

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[68] Caterinicchia, Dan, "Telecenters – Down but not out," Federal Computer Week, http://www.fcw.com, August 6, 2001

[69] We have found some statements that raise concern that the government does not necessarily think that broadband is necessary for teleworkers, even those who would make use of remote network connections to government facilities. As previously mentioned, the telework recommendations indicate that worker need not necessarily even have of computer. This may be a budgetary reaction than a choice away from IT, whatever the case this should be further investigated.

PAPERWORK ELIMINATION ACT

Another promising area to consider is that of the Paperwork Elimination Act. Again, studies surrounding this Act did not explicitly recommend broadband, however much of the underlying requirements could be aided by its use.

EGOVERNMENT INITIATIVE

In July of this year, President Bush gave the following statement concerning e-government initiatives (emphasis added).

> My Administration's vision for Government reform is guided by three principles. Government should be citizen-centered, results-oriented, and market-based. These principles have been woven into the five Government-wide reform goals outlined in my Administration's Management Agenda: strategic management of human capital, budget and performance integration, competitive sourcing, expanded use of the internet and computer resources to provide Government services (Electronic-Government or E-Government), and improved financial management. Effective implementation of E-Government is important in making Government more responsive and cost-effective.
>
> Our success depends on agencies working as a team across traditional boundaries to better serve the American people, focusing on citizens rather than individual agency needs. I thank agencies who have actively engaged in cross-agency teamwork, using E-Government to create more cost-effective and efficient ways to serve citizens, and I urge others to follow their lead.

OMB's agenda is well developed within the OMB 24 e-government initiatives. This effort developed out of an OMB Task Force established to identify priority actions that could best improve government use of communications technology and "set in motion a transformation of government around citizen needs" [OMB E-Gov]. The long term focus of this work was to simplify the delivery of government services to US citizens.

This initiative breaks down into five major areas:

> *Government to Citizen:* This consists of five initiatives including online access to recreation information, employment benefits, loans, Government Services Administration (GSA) services and tax filing.
>
> *Government to Business:* This consists of six initiatives including online dockets, business tax product, GSA assets, trade process streamlining, business compliance info, and health record management.
>
> *Government to Government:* This consists of five initiatives including online geospatial information, grant streamlining, disaster assistance, wireless public safety, and vital records.
>
> *Internal Efficiency and Effectiveness:* This consists of seven initiatives including training, recruitment, human resource management, payroll processing, travel, acquisitions, and record management. As this area relates directly to our question, we expand the analysis below.

Initiatives that Address Barriers to E-Government Success: This consists of two initiatives including authentication and federal information standards.

Together these initiatives provide a solid basis for driving government's ability to use ICT. We believe that this initiative should be viewed as critical to the success of preparing government for broadband services and applications. Without the proper logical infrastructure, broadband might be an unnecessary convenience.

SENATE BILL 803

On the legislative side, there is a Bill underway to promote E-government. This bill, S.803, is intended to create a systematic approach for the management of federal government information technology. It focuses directly on the issue of making government more efficient both internally and outside. Contained within S.803 are a number of enactments directed at promoting various aspects of E-government including:

- Development of an E-government office
- Delegation of authority
- Requirements for federal courts
- Accessibility and usability of government information
- Privacy
- Federal IT training
- Community technology centers
- Funding studies

In terms of stimulating broadband, this Bill may be viewed as resolving a number of underlying problems that stand in the way of broadband demand, but it does not in and of itself position itself as a broadband demand Bill. The various issues that this Bill addresses are critical to the laying the foundation for broadband. For example, this Bill focuses on the notion of making government records readily accessible to citizens. It provides funds for training Federal employees in the area of IT. It provides funds for studies where disparities that exist within society and ways to resolve these disparities. It provides funding for a digital certificate authority within the government (this may well have the biggest impact by jump-starting PKI. It also creates a budget and an office assigned to examine these issues on an ongoing basis. Individually, these items may not spur broadband demand, but together they will provide the collective inputs required for spurring such demand.

A strong emphasis placed on the correct use of the proposed information and communications technology is necessary to usher in the use of broadband intensive service. For example, within the areas of federal portals and accessibility and usability of government information, the proper emphasis being placed on the creation and distribution (particularly DRM) of content; content that will demand high bandwidth infrastructure to use.

OTHER AGENCY AND LEGISLATIVE EFFORTS

As stated, we could not find public documentation suggesting that the Federal government has explicitly evaluated broadband services as a tool to increase efficiency. However, the Federal Government has spent significant effort in trying to understand how to better use information, computer and network technologies to improve efficiency in both internal and external effort (within government and with the public). Further, the federal government is spending a significant amount of funding and effort in promoting ICT outside of government, also as a means of "*increasing efficiency and reducing costs."* Together these initiatives represent what would amount to a significant increase in the available services to the public, which should drive broadband demand.

A variety of supply side opportunities exist within the Federal and state government. For example a number of federally funded grants exist to support innovative or otherwise worthwhile network develops projects. The states have similar programs to assist in the funding of network deployment. Prime examples of recipients of such funding include hospitals for telemedicine and schools for remote learning and distance education. Some funding has been used to rewire public and private facilities with fiber optic cabling.

The Office of Technology Policy within the Department of Commerce plays a role in promoting the use of technology to improve US economic strength; in fact this is their mission. While much of their focus is on the public side of technology adoption, they also provide guidance on the use of technology within government and between government and the public. Several efforts within this office have loosely looked at the role of broadband as a means to improving US economics. We discussed these efforts in previous sections of this report.

The Rural Utilities Service, an arm of the Department of Agriculture, provides grants and loans to rural independent carriers for the development of their networks. This effort clearly could be used to address some of the underserved areas, but may require closer scrutiny by government officials to ensure that it is being used in a manner focusing on the underserved.

A list of other efforts follows:

- HUD's neighborhood networks program funds the development of computing facilities for public use.
- Department of Education funds schools and communities through the Communities Technology Center grants.
- Department of Commerce provides grants to supply low income urban areas with broadband networks.
- Various state governments have passed legislation directed at promoting shared public/private network facilities. They have also created tax incentive programs to invest in underserved areas.
- Numerous conferences have been held at the municipal level to consider how small cities and towns might operate more efficiently by employing technology. This effort has made many recommendations regarding the value of broadband and broadband services to improve the ability to serve the public. Some municipalities are building their own broadband networks to serve both public and private users. Whether good or bad
- The Library of Congress operates a number of useful and well maintained portals, but only a select crowd makes use of this resource. For example, they maintain "Thomas," which provides up to date resources concerning all legislation within Congress. Other portal includes such things as American history, and an "international gateway."

Other legislation is pending within Congress that may have an influence on promoting awareness and use of ICT and more specifically broadband. For example, Senate Bill 2582 sponsored by Senator Lieberman was introduced 6/5/2002. It is entitled, "A bill to require a report to Congress on a national strategy for the deployment of high speed broadband Internet telecommunications services, and for other purposes". It has been referred to the Committee on Commerce, Science, and Transportation. This bill is in agreement with our proposal regarding government initiatives. Further, it makes requirements of the government to look at how it uses ICT. This creates an opportunity to lobby Congress to focus on broadband specifically.

Again, while these efforts might not "*increasing efficiency and reducing costs*" for government itself, there may be efficiencies gains for commerce and the general public.

The question that remains is whether a specific study of the efficiencies broadband could bring to government is warranted. Clearly, the government is making efforts to consider how technology can make them more efficient. Although, while we do believe that government should investigate the use of broadband as a means of improving efficiency, we also believe that this is just one part of a much bigger effort, which appears to be underway. It may be worthwhile for industry to demonstrate/lobby to government why they should be focused more on broadband. This could be in the form of a Congressional request to GAO for analysis of this issue.

What online services and applications could be implemented to improve or add value to Government service to citizens and businesses via broadband access, and thus motivate them to subscribe to broadband?

The drivers we see in the short term include; useful and well promoted federal government portals, government to business online service functions, digital library content and local government portals (and online communities). We could speculate on other services and applications, but we view these as not being near term relevant.

As mentioned earlier, the Federal Government's eGov strategy includes initiatives to improve service for consumers and businesses. For this question, we reviewed the eGov initiatives pertaining to Government-to-consumer (G2C) and Government-to-Business (G2B). G2C initiatives attempt to build easy to find, easy to use, one-stop points-of-service that make it easy for citizens to access high-quality government services. G2B initiatives are aimed at reducing government's burden on businesses by eliminating redundant collections of data and better leveraging E-business technologies for communication.[70] Like the G2G and IEE initiatives, these projects are important to improving Government efficiency, but may not explicitly be broadband drivers.

One Government service we believe is valuable to stimulating citizen's use of broadband is www.FirstGov.gov. FirstGov is a Federal Government Portal providing citizens with access to forms, files, reports and endless bits of esoteric Government data. Its ease of use and quality of service has provided FirstGov with a position among Yahoo Internet Life magazine's "50 Most Incredibly Useful Web Sites."[71] Currently, FirstGov is accessible and convenient even for users of dial-up connections, but we believe this site is extremely important in generating citizens' interest in using Government services online. As citizen confidence grows – as well as FirstGov IT staff – new services and applications will develop requiring more bandwidth.

GSA and OMB are considering ways to make the existing FirstGov a more comprehensive site.[72] This effort extends beyond federal to include state and local resources and focuses on new functionality. They are considering how to employ single sign-on mechanisms to provide this service, dubbed E-Authentication. GSA (with the help of

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70 Office of Management and Budget, E-Government Strategy, http://www.omb.gov

71 Matthews, William, "First Gov among 50 most useful," http://www.FWC.com,

72 FirstGov is the present government gateway portal, see http://www.firstgov.gov

Mitretek Systems, a non-profit government research group) is expected to release a Request For Information (RFI) this summer. This effort is viewed as a means of meeting the Government Paperwork Elimination Act requirements, which mandates all agencies to make information and services available online by 2003.[73] One vendor with whom the government has considered is Microsoft, which has raised the concerns of a numbers of parties. Most of this concern regards the privacy of information, but others have reservations about the monopoly control that this together with Microsoft .NET might create. A pilot study is presently underway.

A second Government initiative we believe is fast becoming a broadband driver is the Library of Congress' National Digital Library Program (NDLP).[74] To date, users can access, via the Internet, video and audio pieces. As popularity grows, we believe this program will build out to all library services. From its kids section, America's Library, where children will soon be able to play interactive games to its Legislative information site, Thomas, where citizens may one day watch live debates or interact with Government representatives, the Library of Congress will drive consumer broadband demand.[75] Obviously, we see the broadband application as library content, including a wide range of specific content, all of which is improved with higher rate connectivity.

Citizen demand of broadband via Government services may take hold first at the local level. The 2001 National Technology Readiness Survey (NTRS) found that over half the Internet users surveyed visited a Government website. More interesting, was that only 33 percent of the respondents visited a federal site while 50 percent visited a state or local Government website. Local Government portals can provide voting information on candidates, referendums, digital video of past and live debates, and virtual town halls, where citizens can debate issues with others from the convenience of their own home. It would be advantageous for companies developing broadband infrastructure to address local government as part of its penetration strategy.

Conclusion

Initial results at ascertaining Government connectivity are moderate, creating only a general view. We believe follow up surveys could shed some light on this topic. However, based on conversations with senior officials within US agencies, it is not clear that the government has a clear understanding of this information.

Whether the government has "effectively evaluated broadband services and applications as tools for increasing efficiency and reducing costs', we believe that it has not. A question that remains is if it should. We believe that it may be worthwhile for industry to demonstrate/lobby to government why it should be focused more on broadband.

As for Government driving broadband internally and externally, it is moving in the right direction. Instead of finding the killer app, it is slowly developing reliable and user-friendly services and applications to better serve their and their citizen's needs. Developers should focus on integrating and improving these needs, rather than attempt to identify the next best thing. Targeting services outside of the Federal Governments traditional sphere of

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[73] "OMB Procedures and Guidance on Implementing the Government Paperwork Elimination Act., M-00-01, 2000.
[74] Periodic reports from the Library of Congress' National Digital Library, http://lcweb.loc.gov/ndl/per.html

[75] http://www.loc.gov

influence, like telecommuting and local Portals will provide faster return on investment.

Telework and the Demand for Broadband Services[76]

Introduction: Broadband and Telework

For modern professionals and mobile service providers, working in a traditional "office" environment physically surrounded by coworkers is often neither required nor desired. Modern work arrangements are increasingly fluid and negotiable, as organizations become more decentralized and team-based. Alternative work arrangements allow employees to work "anywhere" with co-workers who may be in remote locations. The move to what we will call "telework" is typically driven by business and economic considerations: organizational efficiency and effectiveness in meeting business objectives, and employee productivity and satisfaction. These drivers have increased in recent years and that trend is likely to continue. Historically, communication and networking technologies are a significant *enabler* of these work arrangements. In other words, technologies provide the means for teleworkers to remain connected to the office, to information, and to their coworkers. However, it is not clear what level of technological support is needed. Are broadband services needed in teleworking, or if not, are they desired? Are there opportunities in teleworking for increasing demand for broadband services?

At least one recent report suggests there is a strong correlation between broadband subscription and teleworking--in a survey of broadband subscribers, 80% of the households had a teleworker.[77] Our study investigates this correlation more closely to determine what technology-related factors are significant to the practice of telework. We reviewed current research on telework, and conducted a set of interviews with teleworkers from several industries. The results are reported here.

Organization of this report: This report begins with a review and definition of teleworking, its reach within the U.S. workforce, and various drivers for its adoption at governmental, organizational, and individual levels. Next, we briefly describe the methodology of the study and report major findings. Finally, we offer some key suggestions and recommendations for increasing demand for broadband services among teleworkers.

History of Telework

Organizations and their employees have turned to some form of "working at a distance" for over three decades, for a number of reasons. Originally, organizations turned to telework to reduce costs of travel in reaction to government regulation of non-renewable resources. The possibilities for telework were originally fairly limited, given the state of communication and networking technologies. Over the past decade, the advances in these technologies as well as a rise in the number of organizations that are distributed and global and the emergence of a highly mobile workforce across a number of industries, have helped to transform telework from a novelty into a serious work arrangement considered seriously by government and industry. Employees, through the use of

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[76] The Telework research team consisted of Michele H. Jackson, Research Driector, Paul Leonardi, and Natalie Nelson.

[77] ITIA study

communication and networking technologies in their daily work activities, are no longer tied to physical locations or to face-to-face interaction with co-workers and clients. Given current trends, it is reasonable to anticipate that these capabilities may transform our traditional expectations of how people work. Below, we outline a brief history of telework since the term telecommuting was first coined in the mid 1970s.

- *The 1970s.* "Telecommuting" was first coined in the mid 1970s. In response to the Arab oil embargo, the U.S. government issued a mandate to businesses to help employees reduce consumption of fossil fuels. Employers made telephone and teletype machines available to employees so they could work from home occasionally, reducing overall employee commute to the office. Academic and popular literature predicted that work via telephone would revolutionize the working world.[78]

- *The 1980s.* The early part of this decade saw the dawn of the mobile work force in which employees worked from client sites and remote locations. Advances in voice and video technologies supported 'rich' meetings with offices in distant locations (at least as compared to what had previously been possible), enabling geographically distributed work teams to function more smoothly. In addition to the telephone, workers began using networked computers and e-mail to communicate with colleagues with whom they were not co-present.

- *The 1990s.* With the passage of the Clean Air Act of 1990, many companies turned to remote work in order to comply with that mandate. By November of 1994, the U.S. government required thousands of businesses employing more than 100 people "[to] submit detailed proposals outlining a program deemed by the employer as a way to reduce their employees commute time by 25 percent through car pooling, public transportation incentives, condensed workweeks, or the most practical, cost-effective and popular option, telecommuting." [79]The governments of Massachusetts and Oregon responded with official telework policies,[80] and the National Environmental Policy Institute implemented trial telecommuting programs in Washington D.C., Denver, Houston, Los Angeles, and Philadelphia[81] Digital communications technologies such as cell phones, pagers, modems, and laptops ensure access to work resources regardless of time and place, thus prompting work to occur away from the office.

- *The new millennium.* As communication and networking technologies proliferate, researchers and practitioners predict a dramatic change in the way professional work is organized.[82] Teams are expected to become global and wireless internet and satellite connections ensure that employees will have constant access to important work materials regardless of their location.

[78] e.g., Turoff, M. & Hiltz, R. *Network Nation*, 1978.

[79] (Zelinsky, 1994).

[80] http://www.state.ma.us/doer/programs/trans/telecomm. htm

[81] http://www.energy.state.or.us/telework/telehm.htm

[82] Bailey, D. E., & Kurland, N. B. (2002). A review of telework research: Findings, new directions, and lessons for the study of modern work. *Journal of Organizational Behavior, 23*(4), 383-400.
; International Telework Association and council, "Telework bosted in 1998 by Internet and economy." http://www.telecommute.org.

Telework Today

Conceptions of Telework

Telework today is more than just the idea of working at home. Decentralized organizations, teams and project work, and mobile technologies have simply changed the belief in work as tied to a specific location. The terms used to describe telework over its history show the range of commitment to this belief. Each of these terms possesses a slightly different meaning, yet these configurations possess common core concepts. For example:

The term *telework* is most often used to mean the actual arrangements made and the work done in the alternate work location. *Telecommute* is often the term used to emphasize the business or management strategy providing the opportunity and choice for employees to work in an alternative location and in turn provide value for the organization. *Virtual Office* is a related term that extends telework from the individual to the team, or the "operational domain" of work that exists due to communication and networking technologies. *E-Work* is a recent term, emphasizing the view of work as fluid, continuing beyond the traditional work day. Finally *remote employment* typically refers to a specific arrangement in which the worker performs either all or a portion of his or her work at a location other than the employer's central office. The work is fairly well defined (such as a product support) and can be done at the worker's own home or in a teleworking center.

Each of these terms highlights a slightly different aspect of working at a distance. For our purposes, a key distinction is the role of technology: if technology supports the work it is telework, otherwise it is simply remote work. It is important to not conflate all remote work as telework:

> "[C]ommentators who fail to separate the two tend to overestimate the frequency of telecommuting and mischaracterize the effects that digital telecommunications may have on the content and context of work."[83] This point emphasizes the need to not focus on a defining word, but instead to accentuate the core attributes of this phenomenon. The following are the core attributes we use in this study:

- The ability to work at a location not specific to the work being done
- Utilizing technologies that provide interconnection with the organization
- Decrease in amount of physical commuting

In this framework, communication and network technologies are central. Appropriate technological support allows the teleworker to remain connected to information and to co-workers, minimizing the extent to which the work itself needs to be modified.

Reach

Estimates of teleworking fluctuate greatly. In 1988, roughly 15 million part- and full-time telecommuters were estimated to exist, with 4.9 million having formal telecommuting employment relations. Additionally, 35 percent of home workers owned personal computers, more than twice the national average.[84]

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[83] O'Mahony, S., & Barley, S. R. (1999, p. 128). Do telecommunications technologies affect work and organizations? The state of our knowledge. In B. Staw & R. Sutton (Eds.), *Research in organizational behavior* (Vol. 21, pp. 125-161). Greenwich, CT: JAI Press.)

[84] SUNY study

Since then, the number of teleworkers has grown immensely. As of 2000, over 28 million Americans were teleworkers located either at home, at a telework center or satellite office, on the road, or, more commonly, in some combination of these[85]. Most studies of teleworkers typically focus on employees who work solely out of the home, but this classification does not accurately represent the vast majority of teleworkers who alternate between office and remote locations.[86] In this broader definition, *about one-fifth of the adult workforce 18 years of age and older do some type of telework*.[87]

Professional specialty occupations telework the most, followed by executive, administrative and managerial occupations and sales occupations.[88] Compared to non-teleworkers, teleworkers are significantly more likely to be from the Northeast and West, and to have higher education and income. Women have been shown to have a higher desire to telecommute than men. Age also seems to plays an important role in the predisposition of an employee to telecommute. Younger workers (18-44) are more apt to take up an option to telecommute; however, the option to work remotely is most often given to upper level management.[89]

Jobs demanding co-presence or other physical types of interaction or contact, or the use of particular facilities, are not conducive to teleworking. Most teleworkers perform information related tasks, such as clerical work, programming, writing, and data analysis. This indicates that mostly professional, white collar workers are prime candidates for teleworking. Work that requires frequent communication and that revolves primarily around data and document manipulation is particularly well suited for telework. However, if a worker relies heavily on co-workers (to accomplish physical tasks, for inspiration, for group brainstorming, or to answer very specific, critical factual questions), working at home can be both slow and frustrating because the teleworker must wait for return phone calls or e-mail messages. Novice teleworkers and their organizations must be careful not to underestimate the benefits of immediate, informal communication for completing work projects, especially complex or ambiguous tasks.

Increasing Opportunities for Teleworking

Government Initiatives

Opportunities for telework are growing due to policies implemented by the Federal Government. The following policies specifically aid in the adoption and growth of teleworking positions in the public sector.

- Section 630(a) of Public Law 105-277 or the Flexiplace Work Telecommuting Program authorized government agencies to spend a minimum of $50,000 for fiscal year 1999 and each fiscal year following to create and support a telecommuting program.
- Section 638 of Public Law 107-67 titled the Treasury and General Government Appropriations Act, 2002, requires federal agencies to explain their efforts to promote and utilize telecenters as a portion of their telecommuting program.
- In 2001 a hearing was held to examine telecommuting policies in the federal government the use of telecenters operated by the General

85 http://www.telecommute.org/twa/index.htm
86 Bailey and Kurland, 2002
87 http://www.telecommute.org/twa/index.htm
88 http://www.mnwfc.org/lmi/trends/mar00/fact.htm
89 (Positively Broadband).

Services Administration (GSA). The hearing found that telecommuting "not only alleviates traffic congestion and lowers pollution, but if used strategically, it may be an effective recruitment and retention tool in the federal workplace."[90]

The U.S. federal government has described teleworking as beneficial for the following reasons:

- Improves the quality of work and increases productivity due to reduced commute time, decreased stress, and improved morale.
- Focusing on output rather than tracking the hours worked within an office promotes quality of work over time spent at work.
- Providing the opportunity to telework is a tool for recruitment and retention of employees.
- Reducing traffic congestion aids in preserving the environment and lessens the usage of petroleum.
- Teleworking may be useful in reducing the bureaucratic reputation of unavailability by providing services (from a teleworker) when a "duty station" is closed.
- Telework provides employment opportunities for people with disabilities and can also accommodate employees who have temporary or continuing health problems.[91]

  The Federal Government has also advised agencies to write job-specific policies that outline supervisor/employee relationship, responsibilities, proposed schedule, and so forth. This is a prime time to take advantage and advertise the technologies that enable teleworking to be successful.[92]

- Although the government has demonstrated support of telework, implementation of telework is not consistent across agencies and security remains a prime concern.

State Initiatives

Many states are either implementing teleworking positions for their governmental employees or they are providing evidence and initiatives for the private sector to implement. States including Arizona, Massachusetts, and Oregon support the promotion and adoption of teleworking, which offers a number of advantages specific to state government concerns:

- Decreasing stress and pollution. Traffic congestion and air pollution due to commutes have been of primary concern. In densely populated areas, commutes are a source of stress for employees that can result in decreased productivity. The Arizona Department of Health Services reported an 18-25% increase in employee productivity as a result of decreasing or eliminating commuting.
- Decreasing energy consumption. Energy consumption is a related factor to traffic congestion and air pollution. Reducing the usage of the non-renewable resource petroleum benefits society.
- Decreasing overhead costs. The State of Arizona for example spends $33 million a year to lease office space for state agencies. They found organizations could utilize telework as an innovative business strategy to reduce leasing costs.

90 http://www.house.gov/reform/tapps/hearings/9-6-01/Briefing.htm
91 http://www.opm.gov/wrkfam/telecomm/reasons.htm
92 http://www.opm.gov/wrkfam/telecomm/telecomm.htm

Organizational Drivers

Generally, the organizations that adopt telework are those organizations that see it as a solution to their problems of finding and retaining scarce skills, and of cutting costs. Four of the primary organizational drivers for incorporating telework into traditional work practices are:

- Continual escalation of office space rent/ownership costs and the related expenses of security, heat, furnishings, parking, and maintenance.
- The nature of work itself is changing and becoming more "mobile" with workers not using assigned office space nearly as intensively as in the past.
- Highly valued workers with unique skills may demand alternative work arrangements as a condition of their employment; also such arrangements can be used to attract quality employees.[93]
- Time saved from physically commuting from home to office alone can enhance productivity or efficiency.

Individual Drivers

Individual drivers for telework are centralized around the issue of time. Saving time and having the ability to control one's time or maintain a more flexible schedule are consistently noted as important drivers for the desire to telework:

- Reducing the time and aggravation of the "daily commute"
- Accommodating health problems
- Alternatives to parental leave, providing time to be with children
- The ability to minimize work interruptions so as to heighten their ability to concentrate on complex problems
- The ability to control one's own time and schedule, and to avoid micromanagement.
- Desire to increase family time.[94]

Summary

Based on our review of research, we suggest that *the potential market for broadband services among teleworkers will be increased to the extent that broadband (1) improves the ability of organizations to feel connected with their workers, and (2) improves the ability of individuals to control their time and schedule.*

Only recently have policymakers recognized telework for its potential as a market for broadband services. In September, 2002, the U.S. Office of Technology Policy released on broadband demand,[95] with the Assistant Secretary for Technology Policy announcing the day after the report's release that "already the most significant driver for consumer broadband adoption." Broadband is predicted to "transform" telework:

> "Today's remote employees are teleworking in the same way the Wright Brothers were flying in 1903. Pervasive, high-bandwidth computing will transform work from home or remote locations as thoroughly as it is transforming office-based business processes. "[96]

[93] (Ohio study)

[94] (SUNY study)

[95] OTP, 2002. *Understanding Broadband Demand: A Review of Critical Issues. http://www.ta.doc.gov/reports/TechPolicy/Broadband_020921.htm*

[96] Bruce Mehlman, 2002. "Telework and the Future of American Competitiveness" http://www.ta.doc.gov/speeches/BPM_020923_Telework.htm

However, historically, the presence or absence of broadband services in-and-of itself does not appear to act as a driver for either organizations or individuals to choose a teleworking arrangement. And neither does it appear that teleworking drives consumers to broadband, given some current estimates that identify 80% of full time Americans as either teleworking in some capacity, or working with those that do.

In this study, we conduct a careful examination of the relationship between work and technology use, with the aim of providing some more concrete understanding of the nature of the relationship, and recommending ways to capitalize on it effectively.

Central Issues in Telework and Technology Use

Our aim in this study was to investigate in more depth the issues surrounding telework and technology. We interviewed teleworkers to understand the nature of their work and the potentials for broadband demand. The initial sample was populated with (1) an open call to students studying in the Interdisciplinary Telecommunications Department at the University of Colorado, and (2) "cold calls" made to leading companies in targeted industry sectors. As a result, we obtained access to companies in several industries, including public relations, computer manufacturing, paper processing, and telecommunications. Using the snowball method of sampling, in which respondents recommend other persons for us to contact, we have conducted a total of 46 interviews with employees representing 10 industries and 20 companies, working in seven states (and one in the U.K.). Respondents generally shared the following characteristics:

- Professional positions
- High communication needs (working with teams and with clients)
- High information needs (researching, working with documents)

Respondent characteristics are detailed in Appendix A. A standard protocol was used for all interviews (see Appendix B), yielding data points of rough equivalence and therefore allowing systematic comparison across respondents. Interviews ranged from 20-45 minutes, averaging approximately 30 minutes in length.

We sought to have respondents describe not only their use of technology, but also the nature of their work, and their relationship to their organization, their managers, and their coworkers. We identified aspects they were satisfied with, as well as what they wished to see changed or improved. Our strategy was to gather information that would allow us not only to describe the current role of technology, but also to use our understanding of teleworking to uncover potentials and strategies for increasing broadband demand.

Our findings fall into four categories:

- Work Issues
- Organizational Issues
- Technology Use Issues
- Broadband-Specific Issues

Work issues

Surprisingly, past research has rarely examined the work that teleworkers actually do.[97] Yet understanding how telework affects work processes is critical to predicting both the potential reach of teleworking across professions, as well as the possibilities for broadband services to support that work. In this study, we were interested in whether respondents saw their 'telework' as something unique or distinct from their 'normal' work. How did their work practices change for teleworking? We also investigated how they integrated telework with their non-distance work.

Finding 1: "Telework" is just "work." Respondents do not distinguish telework from "normal work." They do not segment their work into "office" work and "home" work. Nor do they consider themselves unusual or experimental in terms of their work practices.

- The term used is not considered important. Common terms included remote work, telecommuting, virtual teaming, and virtual office. In fact, many respondents needed to be prodded in order to come up with a special name for what they did. Most simply referred to it as work while some would add that it was work done from home. Respondents did not differentiate work at home from work in the office.

> "It's just that, I don't know, it's just funny, like I don't really think of myself as a telecommuter, but I suppose I sort of am in a way."

- Teleworkers perceived that they were able to eliminate nonproductive elements of their day, particularly travel. Respondents mentioned how working from home was a duplication of the office experience minus the travel and 'water cooler talk.' Respondents observed that they were much more productive at home.

> "[The reason my company] finally they agreed to have me telecommute was that those two hours [driving] each way, those four hours on average, were essentially dead time."

- In terms of drivers for adopting telework, our findings support previous research. Respondents consistently offered 3 reasons for starting (1) nature of job (sales, distributed teams); (2) geographic constraints (living far from the office and therefore being unable to work for the company if they had to move/commute); (3) personal issues (wanted to be home with children, physical maladies made travel difficult).

Finding 2: Teleworkers divide their work into "tasks" and "relationships." Both of these need support. *Task work* involves things an individual does alone, including writing, research, data analysis, and so forth. *Relationship work* involves those things that must be done with others, including meeting with team members and with clients, mentoring, and supervising.

- Telecommuting task work is more efficient and productive, *as long as the technology supporting the work is sufficient*. Respondents described needing to go into the office when they had connection issues such as a large file to download and no access to high speed internet at home.

[97] O'Mahony, S., & Barley, S. R. (1999)

- Telecommuting makes relationship work more difficult. Most respondents resisted conducting relationship work over a distance.

> "The mentoring part is difficult – you can do it, but it is very difficult, and I don't think it comes off as genuine. It's like, this person has never met me, how can they actually care about my personal and professional development."

The concept of "meeting" someone, of being "face to face" was often identified as critical. Most respondents felt they could not establish or sustain strong relationships through only email or telephone contact. Few offered videoconferencing as an alternative, and some resisted it as an alternative. Given our other findings (e.g., Finding 8, below), however, it is possible that this attitude could change if the technology was reliable and simple to use.

Finding 3: Telework is a continuum. The traditional view that juxtaposes office work to telework is outdated. The extension of the workday beyond "office hours" means that it is more realistic to think of teleworking as a continuum ranging from workers who perform all or most of their work in the office to those that perform all or most of their work at other locations (at home, on the road, at clients' sites).

Implications

Because teleworking often is seen as an "innovative" work arrangement, there is a temptation to identify teleworkers as more innovative also in their use of technology. However, our findings show that teleworkers value feelings of doing "normal" work. Thus, we are discouraged from identifying teleworkers necessarily as innovators and "early adopters" of new technology.[98] Instead, technology must fit into existing work practices seamlessly and transparently. We recommend that the largest opportunity is to meet existing demands of tasks (notably transfers of large files) and relationship building.

Organizational Issues

While it is true that there are a growing number of entrepreneurs or self-employed workers,[99] most teleworkers are employed by traditional organizations. For many organizations, teleworking is outside what is considered routine work practices. Consequently, issues that must be addressed include negotiation of telework policies, how to set up the worker's home office, and what kind of training and support to provide. We were interested in how active and supportive organizations were to their teleworking employees.

Finding 4: Teleworkers in "non-tech" companies largely are responsible for creating their work environments, including acquiring technological equipment and support. Most respondents were given no additional support in terms of equipment or technical assistance, as compared to traditional office workers. Technology companies tended to provide more resources; employees of these companies noted they were given laptops and even software to use to telecommute more efficiently (such as instant messaging).

- Certain positions are better supported than others. Upper level managers and IT personnel tend to be given laptops that could be taken from the office.

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[98] Rogers, E. *The diffusion of innovations*, 1995.

[99] Pink, D. 2001. Free Agent Nation : How America's New Independent Workers Are Transforming The Way We Live

Junior employees and new hires often were not 'permitted' to telework.

- For most workers, technical problems caused them to rely on inefficient processes for solutions. Workers adopt "creative" strategies to solve technological problems. When faced with technology problems, teleworkers stay focused on their task. As a consequence, they adopt whatever strategy "works" rather than a strategy that is the most reasonable from a technical point of view. For example, one respondent described running between her "upstairs home computer" and "downstairs work computer" because the first had a DSL connection and the other did not.

> "We have to change our passwords to log into the server every 45 days or so. If you don't change it, it locks you out. Sometimes I forget or something else will happen and I won't have access to all of the files I need. When that happens I just take my computer into the…office and hook it up directly to the network. It downloads all of the right settings and my computers work fine. Some of the people in my division don't have offices they can just go to, so I know it is more difficult for them. I am not sure what they actually do to solve that."

- Technical support is difficult to provide over a distance. Telework setups differ with each employee, and therefore can challenge IT support units.

> "For the most part, it [was difficult to get support] because our St. Louis support teams didn't really know how to, if you were sitting at home trying to dial and didn't get access, you'd have to dial and even though I'm here in California, I have to dial in through the network through St. Louis."

Finding 5: Formal telecommuting policies and statements of expectations are largely nonexistent. Even when policies exist (usually in tech companies), they may not be effective in guiding action,

> "They actually have a telecommuting policy, but I had to clear it with quite a few people. So, even though they had the policy, it wasn't an immediate action… Which, again, is very interesting because they had it as a policy, but it obviously was not bought into throughout the organization."

- Organizational expectations that employees would telework were split into two categories: Routine and negotiated. Some organizations expected members to telework – it was a clear job expectation from the beginning. Respondents noted the requirement to telecommute was never discussed explicitly, but that they understood they would work remotely if they took the job. In contrast, other respondents had to negotiate telework into their job, whether for family reasons, sickness, or to avoid relocation.
- Teleworkers are expected to control their own schedule. Some organizations had methods for tracking productivity – such as checking a worker's Outlook calendar. Generally, however, respondents believed that it was obvious to others whether or not a teleworker was actually doing the expected amount of work (both in terms of productivity and in terms of actual time on the job).

Finding 6: Most organizations provide little to no support for their teleworkers. Teleworkers indicated that they learned "on the job" how to telework. Organizations sometimes supplemented the experience with literature or short training seminars, but not at the outset of the job. The idea of "economic" or "organizational" support—in which the organization helps the employee by shouldering some of the burden of working away from the office—did not resonate with the respondents. They had not considered that possibility.

- There are best practices or lessons to be learned that could be used to support new teleworkers. Although respondents largely felt they did not need training, they were forthcoming with advice. The advice was consistent across respondents, including schedule your work, be able to put it away, and have a separate room from which to work.

Implications

Reports in the popular press offer several "success stories" of organizations that have used telework to transform their businesses. Our research suggests, however, that for the most part, these stories do not represent typical experience. Organizations expect individuals to learn how to telework in the same way that we might expect children to learn to swim by jumping in the deep end of the pool. Organizational policies are ad hoc and fragmented and workers are not given support they need. Yet the trend clearly points to increased numbers of teleworkers in the near future. An opportunity exists for the formation of "telework service providers," who offer packaged, standardized, "turn key" solutions for organizations or individuals interested in teleworking. These solutions could include not only technical set up and continuing technical support, but also training in how to develop and sustain effective teleworking practices.

Technology Use Issues

Technology is the core enabler of telework. It is what makes telework possible. Technology connects workers with their organizations and with each other in real time. Given advances in communications and information technologies – including not only computer-based technologies but also mobile and wireless technologies – many more options are available to today's teleworkers than to those of the past. Our interest was in gathering a more specific and concrete picture of what technology teleworkers use, and how it is integrated into their work practices.

Finding 7: Technology is a core attribute of telework. Results confirmed our expectation that technology is an essential component of telework. Respondents consistently indicated that without the ability to access documents, databases, intranets, etc. they could not do their job.

- Teleworkers consider technology to *support* their work, but not to *drive* their work. Technology is the backdrop, a necessary requirement for work; many commented "I don't even think about using technology in my work, it is just work." Surprisingly, respondents often had difficulty thinking of how they used technology. They would comment that they used the phone "if that counted as technology" and the computer. Respondents often were ambivalent about technology in general, indicating uncertainty about whether new technologies would really improve their jobs – most did not care about alternate technologies.
- In terms of computer technology, software applications are more salient than hardware configurations. In discussing how they used technology, respondents would often list first the

software they used and then finish with a list of hardware. Most respondents used word processing and also email software to communicate messages and share files. Hardware uses were of computers, telephone, fax, cell phone, and occasionally a copier. When asked what technology was the most essential for her job, one respondent commented, "I hate to say it, but email. I don't know, I can't, I mean I worked before we had email, but I can't even imagine how it was."

Finding 8: Teleworkers use established technologies, but will adopt innovative technologies if they meet communication and information needs.

- Technologies were used primarily for information transfer and for communication with clients and co-workers. Respondents suggested they used computers and the Internet to stay in touch with other members of their teams more than they used the same technologies to create documents.

> "[I use technology to keep in touch with people. And to make sure that on the days that I'm not in the office I can keep things moving."

- Established technologies are seen as most critical. Email and telephone calls are the most critical tools for the teleworker. Email includes attaching reports and other documents. Perhaps because of their reliance on technology, teleworkers were not closed to the idea of using technologies in novel ways. For example, several respondents in a technology company used instant messaging to keep in touch informally with co-workers. One respondent recounted a conference call presentation she was giving when a coworker "IMed" her and pointed out a mistake which she was able to correct right away. Other respondents described "IMing" as a social outlet. Many respondents noted they did not have videoconferencing; however, no one was really sure they needed it. When discussing video conferencing as a possibility, respondents noted that everyone using it would need high-speed access in order for its implementation to be successful.
- Teleworkers generally did not perceive a need for more technologies or applications. In response to an open ended question concerning whether they felt they needed additional technologies or capabilities that could be provided by technologies, few respondents had any unmet needs. When probed as to whether they would welcome additional capabilities, teleworkers were not resistant, as long as the technology did not interfere with their work.

Implications

Teleworkers are not technological innovators. However, teleworkers accept that they depend centrally on technology for accomplishing their work. If a technological capability is made available to them, and once it is integrated into their work routines, teleworkers are likely to come to depend on it.

Broadband-Specific Issues

Teleworkers seem prime candidates for residential broadband service. Yet previous studies, as well as this one, support that fact that the availability of a technology is not a sufficient reason for teleworkers to adopt it. Telework does not by itself drive broadband adoption. Given this, we were interested in comparing broadband and non-broadband users in terms of their satisfaction with their technology. The aim of this analysis was to understand more deeply the factors that make teleworkers committed to certain technologies over others.

Finding 9: Dial-up connections dominate. With only a few exceptions, our respondents connected through traditional dial-up phone lines rather than through broadband. Several connected though 800 lines, several through an extra business line, and one through satellite (we do not know if this connection was broadband). Not all had broadband service available in their area. For those who did, the decision not to subscribe was the result of a cost-benefit analysis, with benefit having to be measured in terms of increased work productivity. While they acknowledged that slower connections meant wasted time or lower productivity, they would argue they were getting by on what was available.

> "I don't think it [broadband service] is that important. I mean, I don't have it now and everything gets done fine. I suppose it would be nice if things were faster, but I am not sure that it would make me more productive."

- High download time is a problem. Many respondents complained of long download times. For those *without* broadband access, the problem was seen as something that was unavoidable.
- A perceived lack of organizational support was a factor against broadband adoption. Several respondents expressed concern that there was no way to hook up to their network with broadband, and that their company would not pay for broadband.

> "If you could find a way to bill it back to the client, which I doubt [they would pay for it]. Because it's my request that I'm working from home, so, it would be hard to bill to the client."

Finding 10: Few respondents knew what "broadband" was. Many had no broadband service. Most referred to it or understood it as high speed internet access. "DSL" was sometimes used as a replacement. Employees of technology companies were somewhat more confident in their definitions.

- Respondents with broadband access view it as indispensable. Those who have broadband access swear by it. Without it, they say, they could not do such things as download large files, or use the phone and stay connected simultaneously. They argue that without it, they could not do their job: broadband enables them to be teleworkers.

> "Two weeks ago, finally, Hazelnut Creek put in high-speed Internet access through the cable company, absolutely was not available before that time. Drove me crazy. Almost broke up my whole family. We were always fighting over the telephone lines, seriously."

Finding 11: Requirements of teleworking practices potentially can drive broadband adoption. Respondents are committed to making their arrangements work. These commitments are consistent with the opportunities afforded by broadband, either because broadband can solve current inefficiencies, or because it can meet perceived requirements.

- Downloading is a source of inefficiency. We heard several stories of people doing ridiculous things in order to download files. For example, one respondent who was connected via modem in her downstairs office would run upstairs to her family computer connected through the broadband she personally paid for in order to download a file. She would then save the file to disk and run back downstairs to work.

- <u>"Always on" connection is highly valued</u>. Everyone stressed the importance of sharing files and being constantly connected to the Internet – in many cases the Internet was their sole form of formal communication with the outside world. Respondents described it as their means of communicating with clients, their teams, managers, and so forth. Many respondents saw their cell phone as making them continuously available to others. Dial-up users generally acknowledged they did not have 'always on' connection.
- <u>The need to send faxes is a source of inefficiency</u>. Email is used to replace fax but the files are large. Respondents constantly mentioned the *waste of time* waiting for downloads or being knocked of the connection.
- <u>Multiple and independent means of connection are highly valued.</u> Every respondent mentioned needing an extra phone line. They expanded on this by describing the necessity to separate home life from work life. The extra phone line generally tied into a conversation about the necessity of having a separate environment for work and home.
- <u>High speed, high bandwidth connections are highly valued for relationship building</u>. There is a connection between those respondents who mentioned the face to face connection missing from their telework experience and those who felt the need for a team to all be connected to high speed internet. This points to the importance of *connection* to relationships. Examples of connection could be through video or audio conferencing, or instant messaging.

Implications

As noted above, the key to unlocking telework as a driver for broadband adoption is "getting a foot in the door." There is an opportunity for improved branding and product recognition. Further, the primary drivers for broadband adoption among teleworkers seem to be (1) increasing efficiency of specific tasks that require transmission of information, (2) allowing continuous and reliable connection to the organization *and to each other*.

Conclusions and Recommendations

We began by asking two questions: Are broadband services needed in teleworking, or if not, are they desired? Are their opportunities in teleworking for increasing demand for broadband services?

Our results suggest that the first question should be asked in reverse. First, are broadband services desired? Teleworkers who have broadband access are strongly committed to it. Broadband has changed their perception of the minimum amount of technology required for them to be productive. However, aside from a few instances, it has not generally changed the *substance* of their work: the actual work remains much the same. What *does* change is the ability of the teleworkers to manage time and manage relationships – both of which are core challenges to working at a distance.

Teleworkers who don't have broadband services don't necessarily desire it. In fact, they might not even know what it is. They would not phrase it as "wanting broadband" (or the services or content that broadband could deliver); instead, they are motivated to remove the problems created by dial-up access.

Second, are broadband services needed in teleworking? Broadband services will be needed to the extent that teleworkers must exchange large amounts of information and must communicate frequently with others. Adapting and capitalizing on the trends in this area are critical for capturing a "teleworker market." Teleworkers deal mainly in documents and conversations. The size of documents is steadily increasing, and can be expected soon to overload dial-up configurations. If technologies for communication become mainstream—such as instant messaging—teleworkers are likely to turn to always-on connections to meet these core needs.

Third, are there opportunities in teleworking for increasing demand for broadband services? Our results suggest the following strategies might increase demand:

8. Make broadband affordable to teleworkers specifically. For example, negotiate with organizations for reduced cost broadband access for their workers. Teleworkers are accustomed to paying for components of their technological support. Reducing the cost of entry while specifically supporting telework may drive adoption with an added effect of increasing the number of teleworkers.

9. Emphasize improved productivity and efficiency, rather than increased content. Although teleworkers do use the Internet for research, none perceived that they could not get desired content. Many teleworkers were upwardly mobile: appeals to improving their individual performance could be effective.

10. Further investigate technology for supporting relationships. Building and maintaining relationships was perceived as the biggest challenge in telework. However, we do not have enough evidence to conclude what technologies or work practices would help teleworkers to address this challenge. Continued study in this area is recommended.

11. Package excellent technical support with broadband access. Teleworkers are not technological innovators, in part because they must have a low tolerance for error. If their technology fails, they cannot be productive. Relying on company IT units is risky because they are not on site. Teleworkers may be willing to purchase broadband if the service can be highly reliable and backed by fast, premium service that extends to application support (email, web, FTP, VPN).

12. Work with access providers or organizational consultants to develop a "turn-key" telework package. Given the steady rise in teleworkers, and the continuing ad hoc nature of telework arrangements, this could be a significant opportunity.

13. Emphasize the reliability and stability of broadband access, rather than its ability to support new and innovative work practices. Teleworkers are more likely to adopt technologies that are established. They are also more likely to adopt them if they seem similar to what they already have—but just better at it. Our respondents saw broadband simply as a 'faster' dial-up.

14. Finally, make broadband easier to understand. Though there may still be debate over what broadband can be, or should be, the fact is that many respondents did not know what "broadband" was.

APPENDIX A

Respondent Characteristics

The sample for this study was 47 individuals working at a distance with others and supported by technology. 21 different companies, entrepreneurial ventures, or governmental agencies were represented. Size and scope of companies ranged from individual start-ups to state level (governments) to international.

Respondent locations:

- California
- Colorado
- Florida
- Idaho
- London
- Ohio
- Utah

Industries/Sectors:

- Computer manufacturing
- Telecommunications
- Paper manufacturing
- Organizational consulting
- Publishing
- Marketing
- Public relations
- Stockbrokering
- Engineering design
- State government
- Public affairs
- Banking

Positions held:

Entry Level through Vice President Level (assistants, managers, managing supervisors, district managers, partners, executives, vice presidents)

Professions/Job Titles:

- Account Management
- Author
- Consultant
- Engineering design/product manager
- Government Affairs Officer
- IT application specialist
- IT System Architecture and Design Operator
- Market Analyst
- Marketer
- Product Manager
- Relationship Manager
- Sales Professional
- Stocktrader

Appendix B

Interview Protocol

Teleworking Research Project

University of Colorado.

Michele Jackson, Research Director.

June 11, 2002

[If consent given, begin interview]

[Stylistic note 1: Replace (1) name of specific company they work for where schedule calls for 'organization' and (2) term they use for telework, given in answer to first question.]

[Stylistic note 2: These are in-depth interviews; therefore, the subject may answer them out of order. Be aware of this and skip over questions that have already been answered, transitioning to the question following. Always prompt for specific examples when you can.]

I. Arrangement

We're interested in people who work at a distance – telecommuting, or teleworking. What do you call it?

How long have you been teleworking?

How did you get started?

Listen/prompt for:

Did you have to negotiation with your boss?

How supportive were they?

Were there barriers or problems

What made you decide to telework?

Do you enjoy it? Why or why not?

What kind of support do you get from your company?

Listen *and prompt specifically* for:

Economic support

Technical support

Social support

Training

Has that support changed over time?

Is it enough?

What did it take to set it up?

How much did the company set up for you, and how much have you had to do (gotten to do) on your own?

Do you have all you need?

What *technology* has turned out to be essential *or most valuable*?

Why?

Is this a surprise?

Any support/capabilities you don't have, but wish you did?

Have you ever had any problems with your set up? How were the problems solved?

II. Work

What kind of work do you do?

Listen for: Formal Responsibilities, Job description, etc. as well as informal description

Has your work changed since you started teleworking?

Describe a typical day in your job. Describe a typical week.

How much control do you have over your time or your schedule? [If they have a lot] - Do you do anything special to control your own work?

What do you enjoy about your job?

How do you use technology to do your work?

Prompt for: and so, what are the specific ways you need to use different technologies?

Listen for: software used, hardware used, connections used, databases, etc. especially uses that require (1) big pipes or (2)always on connection.

How important is networking technology to doing your job?

How much of your work depends on technology?

Has the way that you work with technology changed because of teleworking?

Has you job been made easier, or more difficult because of TW?

Look *and prompt* for lots of e.g.s *in these areas*:

Social

Economic

Technical

Does teleworking help you to do your job *better* (than if you couldn't telework)?

Any part of your job you can't do at a distance?

Why?

What do you do to get that part of your job done?

Could you do it if you had the appropriate technology (e.g., broadband, wireless)

III. Relation to the organization

What's your position in the organization?

Is this is a standard position in the org? (or more entrepreneurial?)

Do others in positions similar to this telework?

Do you feel your organization generally is supportive of telework? In what ways? Why do you think they are/aren't.

How important is teleworking to the way your company works?

Who gets to telework in your org?

What is it like not to have to go into an office everyday?

Listen for: Control, time, scheduling, etc.

How would you describe your relation to the organization? (Possible follow-ups: Do you fit well? Feel loyal? Needed? Etc.)

How connected do you feel to the organization?

Has this changed over time?

YES: In what ways? Why?

NO: Why not?

Does having network technology help you feel connected to the org at all?

YES: How? Can you give an example?

NO: Why not?

What does it take for a person in this organization to feel connected? To feel a part of the organization?

Does the organization do anything to help you feel more connected to it? (events, programs, policies, etc.)

Do you want to feel connected/more connected to the organization?

YES: In what ways?

How would you do that? (through tech or not?)

e.g., information exchange, FTF visits, visuals, always on, "presence"

NO: Why not? [may have answered this above]

Describe

IV. Relation to others

How often do you work with others?

Who are they?

Do they telework?

Describe your relationship with these others

[If not included above, then prompt as appropriate]

What about with your manager?

With your subordinates

With your team members?

How do you keep in touch with them?

Do you feel connected to them? [try to distinguish from organization connection]

Do you think they feel connected to you?

Are there any times that your work requires meeting face to face with others?

V. Relation to self

What do you see yourself doing in 5 years?

What are your career goals?

Do you see teleworking now as having any affect on that?

Within the organization? Overall?

What is the effect?

Why / why not?

Do you have any advice for other people who are thinking about teleworking?

Benefits / drawbacks

Anything you would do differently a second time around?

VI. That's all for my questions. Is there anything you'd like to add? Or to ask me?

Appendix A – Survey Respondent Comments

Caseid	Q48 Comment
10020	Q46 - Retired w/only Social Security Income and a few hundred dollars in interest from savings account. (WEB TV is my only internet access. If this is classified as a computer.
10037	Many of your ISP options don't exist. I work for an ISP & they pay for my access. This affected my answers.
10042	Search engines, are great tools to gather information when doing any research for any school work e-mail is important so you can keep in touch with others who live far away.
10045	I don't know much about satellite connections. I would strongly consider switching to cable access, I live in the boonies and its not available. Also, the 2 dollars was a nice touch, it made me feel more obligated to fill this out. Glad I could help.
10051	Cost is important to me as far as internet access - Because I use it at work most of the time - so I rarely need it at home - so hwy pay a lot.
10061	Your survey missed a crucial reason I do not have high-speed access - amount of hassle with the provider over installation, customer support. I once ordered high speed access. After 3 bungled attempts at coordinating installation, I gave up because I didn't want the hassle. (If they can't install it, why should I believe they can maintain service?) In contrast, the dial-up has NEVER had an interrupting in service (yes, really!) and doesn't even send bills. I don't care if the connection is slow - it is hassle-free. this is the most important reason I stay with dial-up, and it was not part of your survey considerations.
10063	I am not willing to pay a lot for internet service for no more than my family has time to use it. I will be getting service this week though.
10076	We are about to retire (in 3-5years).
10078	I have access to free high speed reliable internet at work - therefore I won't pay a lot for it at home - cost is most feature.
10096	Will probably get a computer sometime in future.
10102	I just happened to be a poor choice for this survey as I am elderly. It was fun though! Thanks.
10110	All the answers he gave would be what I would choose or not choose in a internet service. I still think internet access is outrageous to afford.
10133	Very fast is better but not worth over $50 a month.
10144	I had DSL (SBC -Ameritech) - low reliability and speed; high cost 50/mo - I now went back to dial up (17/mo -reliable Earthlink).
10149	Paying for internet access sucks! RIP OFF!
10153	My answers will show that I valve speed, reliability and an always on connection. Something you did not mention at all that is very important to me is the ability to connect multiple computers to the internet, this is a mush-have.
20176	Although I answered to the best of my ability…frankly I don't really understand computers much less the internet. I did however understand the $$ as the 2 things that keep us from getting a computer: 1. Initial cost + 2. Ongoing cost! Thank you!
20181	My 2nd phone line $20 plus my ISP $122.95 totals $32.95. I would pay up to $35 per month for always on fast service.
20189	I enjoy using the internet but monthly expenses are a great concern to me. I do use it to find information and stay in touch. Speed is a secondary concern.
20203	I or we don't use the net much but don't like being frustrated when we do., If we did use it more I wouldn't pay is more. But why pay for something you don't use.
20205	See front. I teach elementary school. Computer is always on at school. Use home computer mostly for e-mail and letter writing.
20216	Looking for a cheaper monthly fee faster connection and not get kicked off so much.
20226	I am moving from dial up to cable access. I think it's too expensive. In 10 years fro internet and broad band to be viable, homes will be pre connected. Needs to be immediate, reliable, a part of everyday life.
20247	Always on, fast or very fast, no more than $60, very reliable. Not much preference on install time.
20251	When answering, would I switch to various options, many were "maybe" and I answered those "yes".

20267	Always on is a good idea but I think it is also a waste of energy.
20290	DSL, cable are charging to much for small business and home.
20291	Cost & availability.
20294	Would enjoy higher speed access but currently the cost is prohibited.
20297	At this particular time in my life, I am not willing to pay more for convenience b/c I am a college student and I have access to high speed connection, when necessary.
20300	Currently have a reliable high speed cable system installed, works good no complaints
20310	Make it fast, make it cheap, make it reliable!
20314	#43 Did not answer, has no categories that describes me! I am an AMERICAN, born an raised in this U.S. of AMERICA!
30356	I would be willing to go DSL is the mo. Rate were around $25.00 for most of what I use the internet for I just don't need high speed (mostly email, news, some audio).
30368	I pay $40 for always on, very fast reliable service. It's too much, but I pay. Any drop in service or rise in cost, and I'd find another hobby. Sorry for the delay - I lost the original thanks for the two.
30380	My wife is the prime user of the internet in general. I will use it on occasion for other than work purposes but keep a separate e-mail address that I give out. The junk mail and ads go to this address, and allows me more efficient use of e-mail for business purposes.
30383	Price plays a big part in picking an internet provider.
30398	Since we only use internet 10-15 hrs a week, cost is a main factor for us. I wouldn't switch to another service (we're currently on MSN) unless it was faster than our dial-up, but no more than $35 a month. Our current service is very reliable and not much slower than our DSL at work.
30420	My boyfriend who lives with me makes most of the decisions discussed in your survey, so I relied on him for some of the answers.
30431	none
30455	I work from home w/high speed access wife/kids use phone modem and AOL
30466	I would use a High Speed internet connection every day for 15-30 min to obtain information. This service would be worth approx $35- since more and more internet accounts are charging money to obtain information.
30468	I have MSN and it's pretty fast, but I don't like getting ton's of e-mail from advertisers and you can only block 240 or so.
30481	I welcome high speed internet - however I do think it is a bit pricey and would have contemplate the pros and cons.
30486	We mostly use our computers and internet at work.
30488	I don’t use computer much. So with Juno on line, its free. Don't use computer much. Only play games.
30490	Computers are frustrating to use and understand. Each time I turn it on, I hate it more. I would not mind paying for a good internet service if I could pay only for the time on line, I will not pay a monthly fee for something I use as little as possible.
40526	Single parent family work pays for my internet.
40531	Currently, my internet cost is more expensive due to a dial-up contract I do not use. Next March it is finished so my monthly cost will be reduced by $25.00 month.
40541	Because we don't use the internet often, we need it to be low-cost, but reliable, so that when we do want to go on, we can.
40547	Don't have a computer, would like to have one.
40552	My office is very close to home (10 minutes) so it is easy to access the internet via a T1 connection there. If that were not the case, I would have already installed direct high-speed access at home, and in the next few months, we do plan to that anyway.
40593	I'm not into the internet. Just sometimes, for fun thank you for the money. Happy in Vegas.
40600	We used to have a computer and had the internet but we sold it when we had a baby the extra $$ - no time to use the computer.
40602	I would not really want to switch to any of the examples you gave because I currently have cable modem which is always on very fast very reliable and only $45/month.
40622	My current financial situation dictates cost as the stand - out primary consideration. Improvements are certain to alter my answers.
40623	I cancelled my land line phone because I saw no need to pay for two phones. My cell phone comes with software & a cable that allows it to emulate a modem. I am a computer professional who surfs at work & emails at home.

40637	Use only email and have vtech companion.
40647	I work for fun part time in the office at an Animal Hospital. We have four computers. Do all the balancing & reconciling at the end of each day. The computer is wonderful. I give all my earnings to church and my grandchildren. I work for fun (part-time).
40653	President, S-Corp Accounting Firm. No degree after 4 1/2 years college due to car crash and subsequent decline in health.
40668	New person. Don't know much yet!
40676	I only use the computer when I need to loop up something in classifieds or a movie time. I don't really care about the internet.
50708	Reliable, very fast always on week - $17.00 per month - have use of phone while surfing.
50711	Have had a computer for two years, always get kicked off by AOL, must stay on it for 3 years or pay AOL (composure) for computer (get in free for going on line with them for 3 years) Will change access company when contract mass out.
50724	I personally do not use the internet but have my secretaries or technicians use it as search for many materials, etc.
50735	Price means a lot!!!
50741	I choose not to utilize new technology, even after attending and passing basic computer technique.
50767	A need very fast, very reliable, reasonable cost internet access. A do not need always on.-
50769	I don’t' think I am much help in this survey seeing I am too old to have need of this. But it is very useful to others thank you.
50776	Our internet service is through our TV cable Co.
50830	I am too old to start.
50831	Price is important - I would probably contact my children more often but I still enjoy learning their voices when we call each other.
50833	Cost and reliability would be the two most important factors since I am a homemaker. I have not yet learned how to really use the internet.
50847	I would like something to hook up to that is fast, reliable, not too expensive - and could hook up wireless on my laptop.
60877	price of internet access is the most important factor since I don't use it at home very often.
60883	Don't have computer or on line not interested in any of them. Not interested in internet.
60905	Only use the Internet occasionally.
60920	I have a full computer set up which has never been plugged in. I do not know how to use it - yet!
60962	As a retiree, cost is most important to me. I do work part - time for extra income and will not work full time.
60975	Very satisfied with our foresat service - it nearly duplicate that which & experienced during my work at the university. This is a service of a municipal utilities.
60987	My name is Sharma White. William White Jar is deceased. So I filled out the survey I was his daughter. Thanks for the 2 bucks. I hope this helps.
60998	My wife pays the phone bills internet bills, so I'm not sure what the amounts are - sorry.
60999	My 4 children with college degrees use the internet extensively for information and access to newspapers - I have taken 3 courses at Community Colleges but do not feel friendly with a computer. Tried several free internet offers but felt it was too complicated.
61013	Time of day of "not always on" would be useful. I have but don't subscribe to high speed cable service for cost and other reasons.
61015	Right now for me cheaper is better.
61021	I am completely satisfied with my current internet service and would not switch for any reason
61023	AOL on my computer is very slow since computer is older model - I don't use it much, find very little items of interest.
71052	Cost is a primary factor in switching from dial-up for me.
71057	Cost of the service is very important but so is speed and reliability.
71064	Sorry couldn't be of more help.
71071	The two dollars surprised me. Thank you. I hope to have a computer/internet access by next year. Our local cable TV company just started offering cable internet access.
71080	Cost is important, but I would pay more for FAST, RELIABLE access. Always on doesn't matter to me because I'm limited on-line use.

71093	Reliable access #1, speed 2, cost 3. Your questionnaire on Internet leaves out the most important issue, the provider! My first provider was not reliable: often service was interrupted for hours due to problems. When I changed providers the first provider took all my emails saying the emails were their property! The second provider was great until they came up with a new program which you were, forced to switch to with Yahoo. It took out my Internet Explorer; mail came in to the mail sorter as if you had lost your connection and was hard to read! I requested the SBC get this program off my computer and with help I was able to get rid of most of it. Thank heavens I had an update for Internet Explorer which I was able to install. My current provider did not provide a disk to get a connection as they first two providers did, which these programs still "haunt" me. I only had to change my phone number access; it is painfully slow but hasn't messed up my computer to date, didn't add clutter on my hard disk, costs about the same. DSL or cable is not available at this time.
71104	I am on the internet at work for most of the day, for home use, price is the most important aspect.
71136	I currently have cable access which is fast enough for me and is in the price range that I like.
71137	Cost is an important factor followed by reliability.
71148	My son complete the survey.
71171	My experience with free internet services is that they are unreliable and annoying (advertising). $10/month for dial-up is a reasonable cost to acceptable speed for my home use. I also don't have cable TV - why pay for something that you can get for free.
71183	I am 65 years old and do not know too much about the internet and probably will not use it. Therefore did not answer the "options" because didn't think it would be of any use to you.
71189	I want: always on, very fast, very reliable and $20/month. (installation time is not important)
71201	We will be getting a laptop soon.
81246	Cost of internet access is ridiculous. As long as I have internet access at work, I will not pay more than $30/month for a fast connection.
81265	Always on very fast $30. Very reliable.
81289	I use Netzero - free internet.
81292	I have high-speed internet access at work, so I'm not willing to pay much to have it at home.
81298	The internet is very important to me because I have a daughter with special needs.
81301	While we value internet access, our current usage pattern does not justify (to us, at least) spending more than $10/month, no matter how desirable the access features may be. We currently use Juno, which offers free internet access.
81312	Live in a apt., alone don't need computer.
81327	I am employed by a telecommunications CO and get phone and internet at a discounted rate.
81330	High-speed access should be a standard and available in all areas. The price to have high-speed access is too high.
81345	We're happy with what we have for the amount we use it.
81366	Have a hands cape and mother live with. Take are of mother. I do not have a computer, but my daughter has. I do use her & my sister has one I use.
81374	I seldom use the internet and have perhaps a dozen or so people I exchange e-mail with.
99999	Living on "fixed" income. Prices keep going up - can't keep up with cost of living! Thanks for the $2.00.

Household Demand for Broadband Internet Service[1]

Final report to the Broadband.gov Task Force
Federal Communications Commission

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Executive summary

As part of the Federal Communications Commission ("FCC") National Broadband Report to Congress, we have been asked to conduct a survey to help determine consumer valuations of different aspects of broadband Internet service. This report details our methodology, sample and preliminary results. We do not provide policy recommendations.

This draft report uses data obtained from a nationwide survey during late December 2009 and early January 2010 to estimate household demand for broadband Internet service. The report combines household data, obtained from choices in a real market and an experimental setting, with a discrete-choice model to estimate the marginal willingness-to-pay (WTP) for improvements in eight Internet service characteristics. The first three are standard *features* for all current Internet services and include: cost; connection speed; and the reliability of the connection to the Internet. The remaining five characteristics are new *activitie*s that could be bundled with future Internet services. They include the ability to connect to the Internet wirelessly from outside the home, download and watch high-definition movies, designate certain downloads as high-priority, interact with health specialists, and place free videophone calls over the Internet.

Choice experiments are used to estimate household preferences. Respondents are presented with eight choice scenarios, and in each scenario, must choose between a pair of Internet service alternatives that differ by the levels of their characteristics. The information in these choices is enriched with market data by having respondents indicate whether they would stay with their current (actual) Internet service or switch to the hypothetical service they had just selected. The marginal utility parameters of the representative household's utility function, and WTP, are then estimated from all observed choices.

Knowledge Networks Inc. (KN) administered the online survey. Beginning December 24, 2009, KN obtained responses from a sample of 5,799 experienced Internet users and 472 inexperienced users. The demographics of the sample are relatively similar to those reported by the United States Census Bureau.

Our empirical results show that reliability and speed are important characteristics of Internet service. The representative household is willing to pay about $20 per month for more reliable service and $45-48 for an increase in speed. Willingness-to-pay for speed increases with education, income and online experience, and decreases with age. Rural households value connection speed by about $3 more per month than urban households. Households are also willing to pay an additional $6 so that their Internet service provides the ability to designate downloads as high-priority, about $4 for the ability to interact with health specialists online, about $3 for the ability to download and view full-length movies, and about $5 for the ability to place free phone calls over the Internet and see the person being called.

Using these results, we calculate that a representative household would be willing to pay about $59 per month for a less reliable Internet service with fast speed ("Basic"), about $85 for a reliable Internet service with fast speed and the priority feature ("Premium"), and about $98 for a reliable Internet service with fast speed plus all other activities ("Premium Plus"). An improvement to very fast service adds about $3 per month to these estimates. In contrast, an inexperienced household with a slow connection would be willing to pay about $31 per month for a Basic Internet service, about $59 per month for a Premium service and $71 for a Premium Plus service.

An interesting finding from our results is that valuations for Internet service increase substantially with experience. The implication is that, if targeted correctly, private or public programs that educate households about the benefits from broadband (e.g., digital literacy training), expose households to the broadband experience (e.g., public access) or directly support the initial take-up of broadband (e.g., discounted service and/or hookup fees) have potential to increase overall penetration in the United States.

Key words: Broadband, choice experiment, experience, Internet, willingness-to-pay

JEL Classification Number: C24, C25, D12

Table of Contents

1. Introduction

As part of the Federal Communications Commission (FCC) National Broadband Report to Congress, we have been asked to conduct a survey to help determine consumer valuations of different aspects of broadband Internet service. This report details our methodology, sample and empirical results. We do not provide policy recommendations.

Given its enormous potential for improving societal welfare, public policy on broadband deployment and adoption has been one of the most debated aspects of United States telecommunications. Both industry and government have discussed supply-side proposals that would increase the deployment of broadband infrastructure. These include subsidies for universal provision of broadband Internet service provision, providing tax incentives to access providers to build out networks, and the federal funding of appropriate infrastructure initiatives. Several initiatives, contained within the American Recovery and Reinvestment Act of 2009, are "intended to accelerate broadband deployment in unserved, underserved and rural areas and to strategic institutions that are likely to create jobs or provide significant public benefits."[2]

Formal cost-benefit evaluation of these proposals requires, among other things, some understanding of the potential benefits from more widespread access to broadband Internet service. For example, policy makers may want to compare rural household valuations for Internet service to the cost of service provision so they can make a more accurate judgment of the potential subsidy required, or not required, for individual broadband adoption and/or deployment in rural areas. They may also want to use the most recent estimates of valuations to measure the consumer surplus from broadband Internet.[3] The economic construct of

[2] See http://broadband.gov/recovery_act.html.
[3] Goolsbee and Klenow (2006) calculate consumer surplus from the Internet to be several thousand dollars per household at 2005. Greenstein and McDevitt (2009) estimate that broadband deployment (as compared to dial-up access) accounted for about 4.8 to 6.7 billion dollars in new consumer surplus for the entire economy at 2006.

willingness-to-pay (WTP) provides a theory-based, dollar measure of the value consumers place on Internet service, as well as the amount they would be willing to pay for improvements in the individual characteristics that comprise the service. Moreover, because households do not have identical preferences, it is possible to measure how a household's WTP for each Internet service characteristic may vary with observable demographics such as age, education, income, online experience, race and rural location.

This report uses data obtained from a nationwide survey during late December, 2009 and early January, 2010 to estimate household demand for broadband Internet service. The report updates and expands the work of Savage and Waldman (2005, 2009) by combining household data, obtained from choices in a real market and an experimental setting, with a well-specified discrete-choice model to estimate the marginal WTP for improvements in eight Internet service characteristics.

The first three characteristics are standard *features* for all current Internet services and include the:

- price per month for Internet service (*COST*);
- reliability of the connection to the Internet (*RELIABILITY*); and
- time it takes to download and upload information (*SPEED*).

SPEED can be "slow", "fast" or "very fast." Slow has a similar speed to a dial up connection, where downloads from the Internet and uploads to the Internet are slow. It is good for emailing and light web surfing. Fast is similar to a high-speed Internet connection with much faster downloads and uploads. It is great for music, photo sharing and watching some videos. Very fast is similar to a "high end" high-speed Internet connection with blazing fast downloads and

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Dutz et. al. (2009) calculate that the net consumer surplus from broadband relative to dial-up increased by about 60 percent from 2005 to 2008, to $31.9 billion.

uploads. It is really great for gaming, watching high-definition movies, and instantly transferring large files.[4] The remaining five characteristics are relatively new *activitie*s that have the potential to be bundled with future Internet services. They include the ability to:

- connect a laptop to the Internet wirelessly while away from home (*MOBILE LAPTOP*);
- download high-definition movies and TV shows (*MOVIE RENTAL*);
- designate some downloads as high-priority so they travel through the Internet at relatively faster speed (*PRIORITY*);
- interact with health specialists online (*TELEHEALTH*); and
- place free phone calls over the Internet and see the person being called (*VIDEOPHONE*).

We use choice experiments to estimate household preferences and their marginal utilities. A carefully designed choice experiment manipulates the characteristics for a series of hypothetical Internet services to obtain the optimal variation in the data needed to estimate the marginal utility parameters precisely.[5] Respondents are presented with eight choice scenarios, and, in each scenario, must choose between a pair of Internet service alternatives that differ by the levels of their characteristics. The information in these choices is enriched with market data by having respondents indicate whether they would stay with their current (actual) Internet service or switch to the hypothetical service they had just selected. The marginal utility

[4] Although we describe a "slow" service in the survey as having a similar speed to a dial-up connection, readers should not assume that slow is in fact dial up. Section 4.3 shows that about eleven percent of our 6,271 survey respondents indicated a slow speed for their home service. By cross referencing these data with pre-recorded data from Knowledge Networks, Inc. for November, 2009, we know that about half of these respondents actually have a dial-up connection at home (Knowledge Networks, Inc., 2009a). The other half have either a cable modem, DSL, satellite or Wifi connection with slow speed.

[5] It is also possible to estimate the marginal utilities for characteristics that are not currently traded in markets or are only available in limited geographical areas. For example, the mobile laptop characteristic is not widely available, while the telehealth characteristic is not bundled into Internet service.

parameters of the representative household's utility function, and WTP, are then estimated from all observed choices.

Our empirical results show that reliability and speed are important characteristics of Internet service. The representative household is willing to pay $20 per month for more reliable service, $45 for an improvement in speed from slow to fast, and $48 for an improvement in speed from slow to very fast. The latter finding indicates that very fast Internet service is not worth much more to households than fast service. Willingness-to-pay for speed increases with education, income and online experience, and decreases with age. Rural households value connection speed by about $3 more per month than urban households. Valuations for speed increase with online experience and with exposure to different connection speeds. For example, households with less than twelve months online experience and with a slow Internet connection are only willing to pay about $16 per month for an improvement in speed from slow to fast. Among other things, inexperienced households are more likely to be older, non-white, female, and have less education and income.

Overall, households are also willing to pay an additional $6 per month so that their Internet service provides the ability to designate downloads as high-priority, $4 for the ability to interact with health specialists online, $5 for the ability to place free phone calls over the Internet and see the person being called, $3 for the ability to download high-definition movies and TV shows. The ability to connect their laptop to the Internet wirelessly outside the home is not valued by respondents.

Using these results, we calculate that a representative household would be willing to pay $59 per month for an Internet service with fast speed ("Basic"), $79 per month for a very reliable Internet service with fast speed ("Reliable"), $85 for a very reliable service with fast speed and the priority feature ("Premium"), and $98 for a very reliable service with fast speed, the priority feature plus all other activities bundled into the service ("Premium Plus"). In contrast, an inexperienced household with a slow connection would be willing to pay $31 per month for a Basic Internet service, $41 for a Reliable service, $59 for a Premium service and $71 for a Premium Plus service.

Willingness-to-pay

	All Users	*Inexperienced with slow connection*
Basic	$59	$31
Reliable	$79	$41
Premium	$85	$59
Premium Plus	$98	$71

An interesting finding from our results is that valuations for Internet service increase substantially with experience. The implication is that, if targeted correctly, private or public programs that educate households about the benefits from broadband (e.g., digital literacy training), expose households to the broadband experience (e.g., public access) or directly support the initial take-up of broadband (e.g., discounted service and/or hookup fees) have potential to increase overall penetration in the United States.

The report is organized as follows. Section 2 reviews previous studies. Section 3 describes the random utility model of Internet service choice and the econometric method used to estimate the model and calculate WTP. The experimental design, survey questionnaire and data are described in Section 4. Section 5 presents the results from estimating WTP and compares the responses from different segments of the population, and Section 6 concludes.

2. Literature Review

It is difficult to estimate demand for broadband service, and more importantly for specific characteristics of broadband service with data currently available. For example, while there is information about subscription rates to Internet access, pricing and plan choice are not generally available publicly. As a result, it would be difficult to implement the discrete choice methods of Berry et. al. (1995). Moreover, even if these data were available, there is insufficient variation in product characteristics to identify important marginal utility parameters of interest. For example, Internet access service plans are typically structured so that more reliability is bundled with more speed so that it is impossible to separate the willingness-to-pay for these two characteristics.

Previous studies have typically used demographic variables to explain the demand for broadband Internet service ("Digital Divide Studies") or have collected market and/or experimental data from household surveys to explain how price and non-price characteristics affect demand ("Price and Non-Price Characteristics"). A selection of studies from these two approaches is provided below.[6] A caveat is that given the rapidly changing characteristics of the marketplace for Internet services even well-done studies relying on historical data may not provide a sufficiently accurate picture for current policy decisions.[7]

2.1 Digital Divide Studies

Several studies have examined the potential for a digital divide in both the deployment and use of high-bandwidth Internet infrastructure in the United States. Pew Internet and

[6] See Hauge and Prieger (2009) for a more complete list of previous studies of the demand for Internet service.
[7] Specifically, home broadband Internet penetration increased from well under ten percent in 2000 to about 30 percent in 2005 and over 60 percent in 2009 (See Pew Internet and American Life Internet Surveys, 2000-2009). Moreover, services like YouTube did not exist a few years ago.

American Life provide results from periodic surveys of large numbers of households that provide a timeline for studying the characteristics of adoption at any point in time. For example, Horrigan (2009) provides survey results that show that broadband Internet service was adopted by 63 percent of households as of 2009, and that adoption rates differed by income, age and education.

Gabe and Abel (2002) adopt a supply-side approach and count the number of telephone lines with integrated services digital network (ISDN) capability in each United States state from 1996 to 2000. They find considerably more ISDN infrastructure in urban areas and suggest that rural demand for broadband services is generally insufficient to attract new investments in advanced telecom infrastructure.

Prieger (2003) estimates a reduced-form model that relates the decision by a broadband carrier to enter geographic markets to expected demand, costs and entry by other firms. Using FCC zip-code data for 2000, he finds little evidence of unequal broadband availability based on income or on black or Hispanic concentration. He also finds that rural location decreases availability; market size, education and commuting distance increase availability.

Fairlie (2004) uses household data from the August 2000 Current Population Survey to examine racial differences in the demand for Internet service. He models the household's decision to purchase Internet service as a function of race and various demographic characteristics. His model estimates suggest that racial differences in education, income and occupation contribute substantially to the black/white and Hispanic/white divide in home Internet service. Fairlie also finds a negative correlation between rural location and the likelihood of subscribing to Internet services.

Using Forrester data from 18,439 United States households at 2001, Goldfarb and Prince (2008) show that while income and education correlate positively with Internet adoption, they are negatively related with hours spent online. They argue that with fixed connection and near-zero usage fees, low-income people spend more time online due to their lower opportunity costs of time. They suggest that if given the opportunity to go online, Americans without access would likely use the Internet to engage in many of the activities policymakers have stated as the goals of Internet access subsidies.

Prieger and Hu (2008) examine the racial gap in Internet demand in states served by Ameritech at 2000. Because they have incomplete data on the availability and characteristics of all options, they model the probability that at least one household in the census block subscribes to digital subscriber line (DSL) service. They find that race matters independently of income, education and location, in the demand for DSL, and that rural locations have lower demand. Service quality, measured by distance from the central office, has the largest marginal effect on demand and omitting this variable leads to under-estimates of the DSL gap for Hispanics. Prieger and Hu conclude that the lack of options and competition in promotional prices may play a role in creating some dimensions of the digital divide.

In summary, the existing "Digital Divide Studies" have typically used aggregated data and reduced-form model specifications to estimate the effects of income, education, race and location on Internet penetration rates. They do not measure the direct impacts of prices and other quality characteristics on Internet demand and, as such, provide little information on the value households place on different Internet services and individual service characteristics.[8]

[8] Prieger and Hu (2008) indirectly account for quality by measuring household's distance from the central office.

2.2 Price and Non-Price Characteristics

Several other studies use survey and/or experimental data to examine how price and non-price characteristics affect the choice of Internet service. Goolsbee (2006) uses stated preference data from a 1999 survey of about 100,000 consumers to estimate the probability of choosing cable modem Internet service. After controlling for individual demographics, model results show an increase in the likelihood of cable modem service for people with lower prices. The elasticity of demand for cable Internet with respect to price ranges from -2.8 to -3.5.

Hausman et. al. (2001) estimate a reduced-form model that relates the price of broadband to dial-up price, presence of RoadRunner service, and demand and cost variables. Model results cannot reject the hypothesis that dial-up prices do not constrain broadband prices, and they conclude that broadband Internet is a separate relevant market for competitive analysis. However, the finding of zero cross-price elasticity should be qualified to some extent as they do not control for variation in the quality-adjusted prices of Internet service.

Using a sample of 5,255 households in 2000, Rappoport et. al. (2002) estimate a nested logit model where the first branch considers the choice between dial-up and broadband, and given broadband, the second branch considers the choice between cable modem and DSL. Model estimates provide own price elasticities for cable and DSL of –0.587 and –1.462, respectively, and also suggest that dial-up service is not a substitute for broadband users. However, cross-price elasticities of 0.618 and 0.766, respectively, indicate that cable and DSL are strong substitutes for one another.

Dutz et. al. (2009) employ market data from Forrester for over 30,000 households and a similar methodology to Rappoport et. al. (2002) to estimate elasticities of Internet demand. They find that dial-up Internet is not a strong substitute for broadband and that the own-price elasticity of broadband declined from -1.53 in 2005 to -0.69 in 2008. Dutz et. al. argue that their own-price elasticity finding indicates that "broadband is progressively being perceived by those who are using it as a household necessity." They also calculate that the net consumer surplus from broadband relative to dial-up service increased by about 60 percent from 2005 to 2008, to $31.9 billion.

Varian (2002) uses experimental data to estimate how much people are willing to pay for speed. During 1998 and 1999, 70 users at UC Berkeley were able to choose various bandwidths from 8 to 128 kbps through a degraded integrated services digital network line. Varian estimates reduced-form demand for bandwidth with own-price elasticities ranging from -1.3 to -3.1. Cross-price elasticities are generally positive and indicate that one-step lower bandwidths are perceived as substitutes for chosen bandwidth. A regression of time costs on demographics shows that users are not willing to pay very much for bandwidth. Unless new applications and content are forthcoming, or broadband prices fall, Varian suggests there may not be a large surge in broadband demand in the near future.

Savage and Waldman (2005) use survey data, obtained from choices in both a real market and an experimental setting, to estimate a random utility model of Internet service choice. They find that consumers are willing to pay up to $16.54 for more reliable service, $11.37 for a substantive improvement in speed and $5.07 for "always on" functionality. Savage and Waldman (2009) extend their analysis by focusing on preference heterogeneity between urban and rural households.[9] They find that rural and urban households have similar valuations for an improvement in bandwidth; about $8 to $25 per month for low- and high-

[9] Several other studies use a hedonic pricing model to measure the implicit price of bandwidth and various contract features, such as hourly limits and length of contract (Stranger and Greenstein, 2008; Williams, 2008). While informative, both studies use relatively old data and they do not measure how the implicit price of bandwidth may vary across different households and/or different bandwidth thresholds.

ability households, respectively.[10] However, an increase in ability translates into a $3.07 increase in WTP for bandwidth per month for urban households compared to $1.15 for rural consumers.

Estimates from the price and non-price determinants of Internet demand described above are based on survey and/or experimental data that was obtained prior to 2003. Furthermore, these studies do not consider some of the new features that are relevant for current and future Internet services. This report uses the methodology described by Savage and Waldman (2005, 2009), and survey data obtained during December, 2009 and January, 2010 to estimate the WTP for improvements in *SPEED*, *RELIABILITY*, and *MOBILE LAPTOP*, and for the inclusion of *MOVIE RENTAL*, *PRIORITY*, *TELEHEALTH* and *VIDEOPHONE* into one's Internet service.

3. Estimating Willingness-To-Pay

3.1 Empirical Model

The random utility model is used to estimate marginal utilities and calculate WTP. Survey respondents are assumed to maximize their household's utility of the Internet service option A or B conditional on all other consumption and time allocation decisions. A linear approximation to the household conditional utility function is:

$$U^{*} = \beta_1 COST + \beta_2 SPEED + \beta_3 RELIABILITY + \beta_4 MOBILE\ LAPTOP$$
$$+ \beta_5 MOVIE\ RENTAL + \beta_6 PRIORITY + \beta_7 TELEHEALTH + \beta_8 VIDEOHONE + \varepsilon \quad (1)$$

[10] Savage and Waldman (2004, 2009) employ two measures of technical ability. The first is specific to the Internet task as it measures the relationship between Internet experience, i.e., the number of years the respondent has been using the Internet to go online, and the productivity of the individual when using the Internet. The second measure is more general in that it captures the relationship between education, i.e., the number of years of schooling, and the productivity of the individual when using the Internet.

where U^* is utility, β_1 is the marginal disutility of *COST*, β_2 and β_3 are the marginal utilities for the Internet service features *SPEED* and *RELIABILITY*, β_4 through β_8 are the marginal utilities for the Internet service activities *MOBILE LAPTOP*, *MOVIE RENTAL*, *PRIORITY*, *TELEHEALTH* and *VIDEOPHONE*, and ε is a random disturbance. *COST* is the price per month for home Internet service. *SPEED* is the time it takes to upload and download information to and from the Internet . *RELIABILITY* is the reliability of the connection to the Internet. *MOBILE LAPTOP* is the ability to connect your laptop to the Internet wirelessly while away from home. *MOVIE RENTAL* is the ability to download high-definition movies and TV shows. *PRIORITY* is the ability to designate some downloads as high-priority so they travel through the Internet at relatively faster speed. *TELEHEALTH* is the ability to interact with health specialists online. *VIDEOPHONE* is the ability to place free phone calls over the Internet and see the person being called.

The marginal utilities have the usual partial derivative interpretation - the change in utility from a one-unit increase in the level of the feature or activity. *SPEED* and *RELIABILITY* are standard features of all current Internet services; they cannot be unbundled. Given that “more is better”, our *a priori* expectation for these two features is $\beta_2, \beta_3 > 0$. For example, an estimate of $\beta_2 = 0.2$ indicates that a one unit improvement in *SPEED*, measured by a discrete improvement from “Slow = 1” to “Fast = 2”, increases utility by 0.2 for the representative household. *COST* is also a standard service feature, however, a higher cost of service provides less satisfaction so $\beta_1 < 0$. In contrast to the features *COST*, *SPEED* and *RELIABILITY*, the activities *MOBILE LAPTOP*, *MOVIE RENTAL*, *PRIORITY*, *TELEHEALTH* and *VIDEOPHONE* are not widely available in Internet services and/or can be unbundled. The signs and magnitudes of the marginal utilities for these hypothetical features, β_4 through β_8, within a bundled Internet service are an empirical question.

Since the estimates of marginal utility (such as an increase in utility of 0.2 as described above) do not have a readily understandable metric, it is convenient to convert these changes into dollar terms. This is done by employing the economic construct of willingness-to-pay. For example, the WTP for a one unit increase in *SPEED* (*i.e.*, the discrete improvement from "Slow" to "Fast") is defined as how much more the Internet service would have to be priced to make the consumer just indifferent between the old (cheaper but slower) service and the new (more expensive but faster) service:

$$\beta_1 COST + \beta_2 SPEED + \beta_3 RELIABILITY + \beta_4 MOBILE\ LAPTOP$$

$$+ \beta_5 MOVIE\ RENTAL + \beta_6 PRIORITY + \beta_7 TELEHEALTH + \beta_8 VIDEOHONE$$

$$=$$

$$\beta_1 (COST + WTP) + \beta_2 (SPEED + 1) + \beta_3 RELIABILITY + \beta_4 MOBILE\ LAPTOP$$

$$+ \beta_5 MOVIE\ RENTAL + \beta_6 PRIORITY + \beta_7 TELEHEALTH + \beta_8 VIDEOHONE \qquad (2)$$

Solving algebraically for WTP in equation 2 gives the required change in cost to offset an increase of β_2 in utility:

$$WTP(Speed) = -\beta_2/\beta_1 \qquad (3)$$

For example, estimates of $\beta_2 = 0.2$ and $\beta_1 = -0.01$ indicate that the WTP for an improvement in connection speed from "Slow" to "Fast" is \$20 (= -0.2/0.01). Note that the model specification in equation 1 implies that the representative household would also be willing to pay the same amount (\$20) for an improvement in speed from "Fast" to "Very Fast" as it would to move from "Slow" to "Fast." This constraint is relaxed during econometric estimation so that the marginal utility for an improvement in speed from “Fast” to “Very Fast” can be different from the marginal utility for an improvement in speed from “Slow” to “Fast.”

This approach to estimating consumer valuations is used for all other features and Internet activities. The WTP for *MOBILE LAPTOP*, *MOVIE RENTAL*, *PRIORITY*, *TELEHEALTH* and *VIDEOPHONE* is the negative of the ratio of its marginal utility to the marginal disutility of *COST*. In summary, the WTP construct provides a theory-driven, intuitive (dollar) measure of the value consumers place on Internet service and the specific features and activities that comprise the service.

Households may not have identical preferences. Preferences towards speed, for example, may differ because of observable demographic characteristics, or may be idiosyncratic. It is possible to estimate differences in the marginal utility of specific service features to different households by interacting those features with demographic variables. For instance, suppose households in urban and rural locations value speed differently. A specification of utility that captures this difference is:

$$U^* = \beta_1 COST + (\beta_2 + \eta RURAL) \times \beta_2 SPEED + \beta_3 RELIABILITY + \beta_4 MOBILE\ LAPTOP + \beta_5 MOVIE\ RENTAL + \beta_6 PRIORITY + \beta_7 TELEHEALTH + \beta_8 VIDEOHONE + \varepsilon \quad (4)$$

where η is an additional parameter to be estimated, and *RURAL* is a dummy variable that is equal to one when the respondent is in a rural location, and zero otherwise. When location is not important ($\eta = 0$), the WTP for a one-unit improvement in connection speed is $-\beta_2/\beta_1$. When location is important ($\eta \neq 0$), the WTP for a one-unit improvement in connection speed in a rural location is:

$$WTP(Speed) = -\frac{(\beta_2 + \eta)}{\beta_1} \quad (5)$$

Equation 5 provides a concrete illustration of how WTP estimates will inform the design of government programs to promote broadband Internet service in under-served areas. For example, policy makers can use equation 5 to compare rural valuations for broadband to the cost of service provision, and then make a more accurate judgment of the potential subsidy required or, not required, for individual broadband adoption and/or infrastructure deployment in rural areas.

The specification in equation 4 constrains the parameters of the other characteristics (*RELIABILITY*, *MOBILE LAPTOP*, etc.) to be the same for both rural and urban households. To relax this constraint, we estimate the WTP for speed for rural and urban households on separate subsamples of the data. We have this ability because of the large number of respondents answering our survey questionnaire.

3.2 Estimation Method

The hypothetical utility of each service option U^* is not observed. What is known is which option has the highest utility. For instance, when a respondent chooses Internet service A over B and then the status quo (SQ) over A, it is assumed that $U_A^* > U_B^*$ and $U_{SQ}^* > U_A^*$. For this kind of dichotomous choice data, a suitable method of estimation is maximum likelihood (i.e., a form of bivariate probit) where the probability of the outcome for each respondent-choice occasion is written as a function of the data and the parameters. Appendix A provides a detailed description of the method used to estimate the random utility model.

Since the WTP estimates are nonlinear functions of the structural parameters from the random utility model, their exact standard errors for the purpose of hypothesis testing are unknown. We use a linear approximation to the variance, sometimes known as the "delta method," to obtain standard errors for the WTP estimates. Appendix B, provided as an attachment to this report, describes the delta method for estimating the standard error of WTP measures from discrete choice experiments.

4. Data

4.1 Experimental Design

The WTP for Internet service is estimated with data from an online survey questionnaire employing repeated discrete choice experiments. Each respondent answers four choice questions from two sequential choice tasks. In each choice question a pair of hypothetical Internet service alternatives, A and B, is presented. Respondents indicate their preference for choice alternative A or B. The alternatives differ by the levels of the three Internet features, *COST*, *SPEED* and *RELIABILITY*, and *one* of the five Internet activities, *MOBILE LAPTOP*, *MOVIE RENTAL*, *PRIORITY*, *TELEHEALTH* or *VIDEOPHONE*.[11] Each respondent is randomly assigned one of the following survey versions:

1) Priority-Telehealth;
2) Telehealth-Mobile Laptop;
3) Mobile Laptop-Videophone;
4) Videophone-Movie Rental; or
5) Movie Rental-Priority.

In each version, the first activity corresponds to the first choice task and the second activity corresponds to the second choice task. For example, the "Priority-Telehealth" version contains

[11] We want to estimate the WTP for five Internet activities but not to overload the cognitive task for respondents by asking them to evaluate an Internet service with three features, *COST*, *SPEED* and *RELIABILITY*, and five activities, *MOBILE LAPTOP*, *MOVIE RENTAL*, *PRIORITY*, *TELEHEALTH* and *VIDEOPHONE*. Therefore, we constrain the choice task to three features and a single activity with the single activity randomly assigned across all respondents.

four choice questions where alternatives A and B differ by the levels of *COST*, *SPEED*, *RELIABILITY*, and *PRIORITY*, followed by four choice questions where A and B differ by the levels of *COST*, *SPEED*, *RELIABILITY*, and *TELEHEALTH*.

We used the marketing programs from various Internet service providers, a pilot study and two focus groups to test and refine our descriptions of the service characteristics for choice alternatives A and B. The pilot hard-copy version of the survey was given to 71 undergraduate students at the University of Colorado on October 30, 2009. The same day we held the first focus group, with a hard-copy survey, in the seminar room of the Economics building at the University of Colorado at Boulder. Five individuals: a barber, mail clerk, restaurant owner, secretary, and advanced graduate student simultaneously took the survey and then discussed its presentation and content with Savage and Waldman in a group setting. The second focus group, with an online survey, was facilitated by RRC Associates in Boulder on November 19. The group consisted of five diverse individuals with respect to age, gender, and Internet experience, who completed the survey sequentially in the presence of a professional facilitator.

Table 1 describes the levels of the characteristics that comprise Internet service A and B. *COST* is the dollar amount the household pays per month for home Internet service. *SPEED* is the time it takes to receive (download) and send (upload) information from the home computer. *RELIABILITY* is the reliability of home's connection to the Internet. Very reliable Internet service is rarely disrupted by service outages, that is, the service may go down once or twice a year due to severe weather. With less reliable Internet service the household will experience more outages, perhaps once or twice a month for no particular reason. The *MOBILE LAPTOP* feature allows the household to use its Internet service to connect laptop(s) to the Internet wirelessly while away from home. The *MOVIE RENTAL* feature allows the household to use its Internet service to regularly download high definition movies and TV shows from the Internet, and watch them on a computer or TV (saving the cost of a trip to the video store). The *PRIORITY* feature allows the household to designate some of its downloads as high priority so they travel through the Internet at a much faster speed than low-priority downloads. The *TELEHEALTH* feature allows the household to use its Internet service to go online for remote diagnosis, treatment, monitoring and consultations, saving a trip to the health specialist. The *VIDEOPHONE* feature allows the household to use its Internet service to place free phone calls over the Internet and see the person that is being called.

Measures developed by Zwerina et. al. (1996) are used to generate an efficient non-linear optimal design for the levels of the characteristics that comprise the Internet service choice. A fractional factorial design creates 24 paired descriptions of Internet service, A and B, that are grouped into three sets of eight choice questions that are randomly distributed across all respondents. In addition, the information in these A-B choices is enriched with market data by having respondents indicate whether they would stay with their current (actual) Internet service, the "status quo," or switch to the hypothetical service they had just selected, or if they would adopt the service selected if they did not already have service. The parameters of the representative individual's utility function, and WTP, are then estimated from the observed choices.

The research methodology has several important characteristics. First, the experimental approach exogenously determines the levels of the characteristics of each Internet service offered and avoids collinearity problems by offering non-existing alternatives. For example, the values for the service reliability and connection speed characteristics change independently in the hypothetical alternatives as opposed to market data where they often move together perfectly. By asking eight choice questions, we are able to generalize the model by identifying an additional variance parameter, increase parameter estimation precision and reduce sampling costs by obtaining more information on preferences for each respondent.[12] The use of revealed-preference information on each respondent's status quo alternative, chosen in the market for Internet service, into our experimental design helps alleviate any biases in the hypothetical choice setting.[13]

Second, the choice data are used to estimate parameters of the representative household's utility function. This has the advantage that from estimates of these structural parameters, we can construct estimates of the value of *any* variant of current and future Internet services, and any potential characteristic of these services. For example, Athey and Stern (2002) and Savage and Waldman (2009) show that various online health and medicine activities have the potential to improve societal welfare through improved communication and reduced transport costs.[14] Because we include the telehealth activity in our hypothetical Internet service options, we can estimate consumer valuation for online health services. That is, it is not necessary to design separate health plan choice experiments where consumers choose between different health plans with and without an online health feature. Furthermore, because we know the geographical location of respondents, and the deployment of broadband, it is possible to use the WTP construct described in equation 5 to estimate consumer valuations for telehealth in remote and underserved locations.

[12] This information also facilitates the fitting of more sophisticated models with random parameters.
[13] It is possible that market data may introduce an endogeneity problem concerning the positive correlation between market price and quality characteristics observed by the household but not the econometrician. Using a similar experimental design, Savage and Waldman (2009) show that there is minimal correlation between prices and unobserved error differences in the utility function.
[14] The benefits of these activities have been raised in the health and communications literatures, and in discussions with the members of the Broadband.gov Task Force as part of the National Broadband Plan (See, for example, http://www.broadband.gov/broadband_advantages.html.).

Finally, as an alternative to choice questions, we could employ payment-card questions that simply ask respondents what they would be willing to pay for various Internet services, or what they would pay for specific characteristics. However, the literatures on marketing, transportation choice, and environmental economics, show that the quality of these data relative to choice questions and the resulting valuations have proven inferior. Specifically, individuals tend to over- or under-estimate their values when they do not face a clear comparison. However, we employ two payment card questions in the survey questionnaire to break up the two choice tasks and to provide a secondary source of data for future analysis and methodological comparison.

4.2 Survey

Knowledge Networks Inc. (KN) administered the household survey online. There are five versions of the survey, which are identical except for the Internet activity being evaluated and the levels of the features for the Internet services in the choice task. The questionnaire begins with a cognitive buildup section that asks respondents ten questions about their use of the Internet and their current Internet service in terms of the characteristics described in Table 1.[15] Respondents who are not entirely sure what the description of a characteristic means are provided with a prompt screen with additional information. For example, the additional description for *SPEED* is:

> "This is the time it takes to receive (download) and send (upload) information from your home computer. Speed can be slow (similar to travelling on a San Francisco cable car at 5 mph), fast (similar to travelling on an AMTRAK train at 100 mph, or, 20x faster than Slow) or very fast (similar to travelling on the 'bullet train' at 300 mph or, 60x faster than Slow)."

[15] The descriptions of the "Internet Service Features" as they appear in the survey are provided in Appendix D.

Here, the added advantage of the online survey is that only those unsure of their home connection speed will click on the hyperlink and take the time to read the enhanced description, thus reducing potential survey fatigue.

Cognitive buildup is followed by the first choice task where each respondent is presented with four questions that describe a pair of Internet service options A and B that differ by *COST*, *SPEED*, *RELIABILITY* and activity *X* (*MOBILE LAPTOP*, *MOVIE RENTAL*, *PRIORITY*, *TELEHEALTH* or *VIDEOPHONE*).[16] Respondents indicate their preferred choice and then indicate whether they would switch from their home service to the hypothetical service they chose in the A-B choice question (See Figure 1 for a choice question example). Respondents complete the first choice task by indicating in a payment card question how much they would be willing to pay for the service described by levels of *SPEED*, *RELIABILITY* and *X*. In the second choice task, each respondent is presented with four questions that describe A and B by the levels of *COST*, *SPEED*, *RELIABILITY* and activity $Y \neq X$.[17] Respondents complete the second choice task with a second payment card question for a service described by levels of *SPEED*, *RELIABILITY* and *Y*.

KN panel members are drawn by random digit dialing of listed and unlisted telephone households, with a success rate of about 45 to 50 percent. For incentive, panel members are rewarded with points for participating in surveys, which can be converted to cash or other rewards. An advantage of using KN is that it obtains high completion rates and the majority of the sample data are collected in less than two weeks. KN also provides detailed demographic

[16] Carson et. al. (1994) review a range of choice experiments and find that respondents are typically asked to evaluate eight choice questions. Savage and Waldman (2008) find there is some fatigue for online respondents in answering eight choice questions when compared to mail respondents. To remedy this, we have reduced the cognitive burden in this survey in two ways: by decreasing the number of features to be compared from five to four; and by splitting the choice questions into two choice tasks with a different fourth activity feature. The respondent is given a break between the first and second choice task with a payment card question.

[17] To account for the possibility of order effects that could confound the analysis, the order of the eight A-B choices questions in the two choice tasks is randomly assigned across all respondents.

data for each respondent. Because these demographics are previously recorded, the length of the field survey is shortened to under 12 minutes (on average) and ensures higher quality responses from the respondents.

We want to estimate the marginal utilities and WTP for a subsample of experienced users, as well as for a subsample of inexperienced users to provide some indication of valuations for households that are not connected to the Internet. Based on recruitment information, KN knows if a household previously had Internet service, and the type of service, dial-up, cable modem, DSL, etc. We use this information to oversample new recruits to the panel, that is, those with less than twelve months of panel experience *and* who did not have Internet service prior to recruitment ("inexperienced"). There are about 800 panel members that fulfill this criteria.

During the week of December 21, 2009, KN contacted a gross sample of experienced panel members and a gross sample of inexperienced panel members informing them about the Internet service choice experiment. The survey was fielded on December 24, 2009 and by January 18, 2010, 6,271 respondents from all 50 states and the District of Columbia had completed survey questionnaires. 5,799 respondents are experienced and the remaining 472 respondents are inexperienced.[18]

Table 2 presents a selection of demographics for KN's panel members, the full sample, the subsample of experienced respondents, the subsample of inexperienced respondents and the United States population (Knowledge Networks, Inc., 2009a; United States Census Bureau, 2009). The demographics for the full sample are relatively similar to those reported by the Census Bureau. Both the full sample and the experienced subsample differ from the population

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[18] The panel tenure in months for sample respondents ranged from 1 to 121 with a mean of 37.72 and standard deviation of 27.14. See Dennis (2009) for a description of the within-panel survey sampling methodology.

in education, income and employment. The inexperienced subsample also differs from the population with respect to several demographic characteristics. Table 3 presents summary statistics for the full sample, and Table 4 reports the estimates from a probit regression of *INEXPERIENCED* (equals one if the respondent has less than twelve months of panel experience *and* who did not have Internet service prior to recruitment) on selected demographic and regional variables The results show that an inexperienced respondent is more likely to be older, non-white, female, unmarried and with less education and household income.

4.3 Current Internet Service and Use

Table 5 presents summary statistics describing the home Internet service for respondents and their use of the Internet. The top panel shows that most respondents have high-speed Internet service. 22.1 percent indicated that they have “Very Fast” speed, 67.2 percent have “Fast” speed and 10.7 percent have “Slow” speed. About 76 percent indicated that they bundled their Internet service with other services such as phone, TV and/or some “other” telecommunications service, 19 percent to do not bundle their Internet service and about five percent were not sure. The average price for stand-alone Internet service, or the Internet portion of bundled service, is $39.15 per month. The average price per month for slow, fast and very fast Internet services are $25, $39.54 and $44.07, respectively. Over 87 percent of respondents indicated that their home Internet service was “very reliable.” The bottom panel shows that most inexperienced respondents have slow service, do not bundle their Internet connection with other services, and pay an average price of $16.89 per month. [19]

[19] Table 5 shows that 46.4 percent of inexperienced users say that they bundle. This may be a lower-bound estimate as it is possible that many of these new users also get phone service with their DSL service but do not think of it as bundled. This was an issue with early Point Topic data back in 2003 when people did not think of DSL as being bundled with phone service even though it was to the extent that you couldn't buy DSL without it.